[COMMITTEE PRINT]

# BRICK AND MORTAR: A SUMMARY AND ANALYSIS OF PROPOSALS TO MEET RESEARCH FACILITIES NEEDS ON COLLEGE CAMPUSES

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## REPORT

PREPARED BY THE

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SCIENCE, RESEARCH AND TECHNOLOGY

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## LETTER OF TRANSMITTAL

House of Representatives
Committee on Science, Space,
and Technology
Washington, DC September 10, 1987

To All Members, Committee on Science, Space, and Technology:

I am transmitting herewith a report, "Bricks and Mortar: A Summary and Analysis of Proposals to Meet Research Facilities Needs on College Campuses," prepared by the Congressional Research Service.

The report, is an excellent summary of the complex and important issue of funding university research facilities. It provides background information on the current condition of university research facilities, as well as past and proposed mechanisms to allocate federal funds needed to meet the research facility requirements of the Nation's colleges and universities.

I believe this report will serve as a valuable asset as we prepare to address this important issue. I commend it to your attention and the Members of the House of Representatives.

Sincerely,

ROBERT A. ROE
Chairman

RAR/Beg

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Republican Staff Director

LETTER OF TRANSMITTAL

House of Representatives,
Committee on Science, Space,
and Technology
Washington, DC September 9, 1987

To The Honorable Robert A. Rue, Chairman:

I am pleased to transmit herewith a report, "Bricks and Mortar: A Summary and Analysis of Proposals to Meet Research Facilities Needs on College Campuses," prepared by the Congressional Research Service at the request of the Subcommittee on Science, Research and Technology.

The Subcommittee, alarmed by recent reports citing the deterioration of the Nation's university research facilities and recognizing its importance in the training of future generations of scientists and engineers, believed this issue merited a comprehensive review.

The report examines the numerous issues surrounding the funding and condition of the research facility infrastructure at colleges and universities. It includes a historical overview of the federal role in funding university research facilities, a review of various surveys that assessed the current condition of the university research infrastructure, as well as the overall impact of research facilities on education. Additionally, it provides a summary of recent congressional activities and various proposals being discussed to meet the facility requirements of colleges and universities, including the controversial strategy of obtaining facility funds directly from Congress.

I am sure this report will be a valuable resource to the Committee as we face the challenge of meeting the pressing needs of our Nation's university research infrastructure during this time of budgetary restraint. I commend it to you.

Sincerely,

Doug Walgren

DOUG WALGREN, Chairman
Subcommittee on Science,
Research and Technology

DW/Beg

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LETTER OF SUBMITTAL

April 14, 1987

Honorable Doug Walgren
Chairman, Subcommittee on
Science, Research and Technology
Committee on Science, Space and Technology
House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

We are very pleased to transmit this report entitled, Bricks and Mortar: A Summary and Analysis of Proposals to Meet Research Facilities Needs on College Campuses. The report was prepared at the request of the Committee on Science, Space and Technology, Subcommittee on Science, Research and Technology, and examines the current condition of university research facilities. As is characteristic of Congressional Research Service policy reports, programmatic and policy options are discussed impartially, but no recommendations are made.

This report was prepared by a team of CRS analysts under the coordination of Michael E. Davey, Analyst in Science and Technology. Edith F. Cooper, Analyst in Social Science, prepared chapter IV. Christine Matthews Rose, Analyst in Science and Technology, prepared chapter V. Mr. Davey prepared the rest of this study and edited the entire manuscript.

We appreciate having been asked to undertake this analysis of critical Government programs and policies in this vital area of university research. We hope this report meets the needs of the House Science Committee.

Sincerely,

Joseph E. Ross
Director

Congressional Research Service
The Library of Congress

Washington, D.C. 20540

# BRICKS AND MORTAR:
# A SUMMARY AND ANALYSIS OF PROPOSALS TO MEET RESEARCH FACILITIES NEEDS ON COLLEGE CAMPUSES

Prepared at the request of the House Committee on Science,
Space and Technology
Subcommittee on Science, Research and Technology

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April 13, 1987

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## ABSTRACT

This report examines the current condition of university research facilities that are considered part of a college or university campus facility. The report reviews past and present federally sponsored programs designed to help the Nation's universities expand and modernize their research facilities. Recent surveys conducted by higher-educational associations and the Federal Government, to assess the current condition and level of research facilities construction activities of the Nation's universities are also discussed. Finally, the report presents a number of different issues Congress may eventually have to address, in considering current university concerns about their research facilities.

# CHAPTER I. INTRODUCTION

In the past several years, there have been increasingly disturbing signs that higher education's infrastructure[1] for supporting research and development is deteriorating. The Nation's universities play a crucial role in support of America's research and development (R&D) enterprise. Universities now perform over half of all federally sponsored basic research[2], and 13 percent of all federally sponsored R&D.[3] Universities and colleges are also responsible for training the bulk of our future scientists and engineers, and professionals. Consequently, the ability of our institutions of higher learning to successfully carry out these responsibilities is a matter of great national concern.[4]

A number of different individual analysts and reports strongly suggests that the Nation's university research facilities are in such poor condition, that they undermine the universities' ability to achieve their primary responsibility of teaching and research. In his book, Crumbling Academe, Harvey Kaiser, from Syracuse University, assess the current conditions of university facilities in the following manner: "The halls of academe are crumbling. Buildings, grounds, and utilities . . . are in dilapidated condition, endangering life and property. The vitality of the higher education enterprise is in jeopardy."[5]

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[1] According to the National Science Foundation, infrastructure is defined broadly to include not only the supporting environment for academic research--the facilities, equipment, information resources, and institution relationships--but also the human resources that comprise the system--the faculty and graduate students. As implied, the infrastructure is taken to include not only support for current university research, but, the education and training of those who will do future academic research as well.

[2] Federal Funds for Research and Development: Fiscal years 1985, 1986, and 1987. v. 35. National Science Foundation. p. 52.

[3] Ibid., p. 13.

[4] Wilson, Linda S. The Capital Facilities Dilemma. In "The State of Graduate Education" Ed. Bruce, L. R. Smith. Brookings Institution. Washington, D.C. 1985. p. 121.

The National Science Foundation's (NSF) recently released survey, on the condition of university research facilities, at 165 doctorate granting institutions challenges Kaiser's observations. According to NSF, the survey results suggest that despite the absence of an active Federal involvement in research facilities funding, the universities surveyed have embarked on a very aggressive mix of investment strategies in order to respond to their various research facilities needs. Further, the survey results indicate that over 80 percent of both private and public universities have been involved in or are planning new research facilities construction activities in the next three to five years.[6]

However, in general, the higher educational community is not happy with how NSF chose to interpret its survey findings. The academic community contends that NSF's report to Congress tended to accentuate the positive aspects of the data, while underplaying the data's negative implications.

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[5] Kaiser, Harvey H. Crumbling Academe: Solving the Capital Renewal and Replacement Dilemma. Washington, D.C. Association of Governing Boards of Universities and Colleges. 1984. p. vi.

[6] Science and Engineering Research Facilities at Doctorate Granting Institutions. National Science Foundation, Sept. 1986. p. 13.

Prior to World War II, the Federal Government played a limited role in the support of university research facilities. However, during and after the war, the Federal Government emerged as one of the primary supporters of university research facilities. The growth of Federal funding for university-based research, included helping to finance modern and expensive research facilities.

In 1942, Senator Harvey M. Kilgore, Chairman of the Subcommittee on War Mobilization, opened three years of hearings on the formation of science policy, but they did not address Federal Government support for research facilities. Further, Vannevar Bush's report, Science-The Endless Frontier, which established the postwar justification for Federal support of research, did not mention the subject of public support for research facilities.[7] Not until the 1947 Steelman Report, which examined the status of American science, were facilities discussed. The report recommended, "that the Federal Government provide aid to education institutions for the construction of facilities and the purchase of expensive equipment. A beginning was made on this with the disposal of surplus property. It must now be put on a long-run basis."[8]

In the 1956 Annual Report, Alan T. Waterman, the director of the National Science Foundation, (NSF) wrote that "when other sources are not available, the Federal Government must continue to provide funds for large scale facilities urgently needed for important basic research."[9] The NSF report indicated that the growing need for more sophisticated research facilities was a long term phenomenon that the Federal Government would have to respond to on an ongoing basis.

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[7] Stine, Jeffrey K. and G. A. Good. Government Funding of Scientific Instrumentation: A Review of U.S. Policy Debate Since World War II. Science Technology and Human Values, Summer 1986. p. 43.

[8] Ibid., p. 35.

Consequently this report raised two new policy issues. First, the high cost of research facilities often exceeded the resources of universities and private funding, and would require the Federal Government to find resources to support this need. Second, and perhaps more important, it was found that the cost to maintain these facilities was higher than originally anticipated and that Federal funding policy should take these ongoing maintenance costs into account.[10]

Despite these early calls for Federal support, NSF data show that most direct support for construction and renovation of university research facilities has always been from non-Federal sources (e.g., State government, private giving, borrowing, and institutional funds). Federal tax policy, however, has encouraged private and institutional giving through foregone revenues. Nevertheless, with World War II and Korean veterans filling existing university classrooms and laboratory space, and the successful launch of Sputnik, direct Federal support of university facilities grew significantly. By the mid 1960s until the early 1970s Federal funding for university research facilities accounted for 25 to 30 percent of the total. Even at the greatest level of contribution, the direct Federal share never surpassed a third of the total.[11] NSF points out that these figures included the cost of expensive research equipment as well. Recently released studies of Federal support for university research facilities estimate that the Federal share has now dropped to well below 10 percent of the total actual expenditures.

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[9] Ibid., p. 36.

[10] Ibid.

[11] The Adequacy of University Research Facilities. PRA Issue Paper 83-64, National Science Foundation. Feb. 8, 1984. p. 2.

William D. Carey, Executive Officer for the American Association for the Advancement of Science, asserted that "postwar funding policies were critically flawed in that they ignored the requirements for reinvestment in infrastructure, with the result that a massive reinvestment deficit has accumulated with predictable costs and consequences downstream."[12] Along with Carey, others in the scientific community believe the Federal policy of trying to support the university infrastructure through individual project grants was a serious error. This approach allowed researchers to request funding for new research equipment, necessary to conduct their research, but made very little funding, if any, available for research facilities. Consequently, as many of the reports reviewed for this document have indicated, some of the Nation's universities now find that they have a large unfulfilled need for new academic research facilities.

While research instruments are the tools scientists use to gather data, facilities are the environment within which the instruments are used. These two aspects of the physical research infrastructure are in most cases interdependent. Modern research facilities not only provide a location in which to use research equipment, in many cases they provide a carefully controlled physical environment required for the successful operation of many state-of-the-art measuring devices.

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[12] Stine and Good, op. cit., p. 35.

This report focuses on the current condition of university research facilities that are considered part of a college or university campus facility. The report does not discuss national laboratories that may be associated with a university, but are usually treated as a separate R&D facility, with its own budget and administrative staff.

Chapter two presents a number of different issues Congress may eventually have to address, if the universities are to overcome their current problems with research facilities. Chapter three of this report contains an executive summary of the major findings. Chapter four presents an historical overview of Federal support for university research facilities. Besides reviewing Federal funding trends for facilities, the chapter highlights some of the early university research facilities programs that were supported by the major Federal R&D agencies. Chapter five reviews recent congressional activities in the area of university research facilities. Specifically, the chapter summarizes recent congressional hearings that have been held to evaluate the current conditions of the Nation's academic research facilities, as well as legislative proposals designed to help the universities with their research facility needs. Chapter six reviews recently conducted surveys of academic research facilities, including NSF's September 1986 report to Congress, entitled, Science and Engineering Research Facilities at Doctorate-Granting Institutions. Chapter seven analyses a number of various proposals to help universities finance the construction and renovation of their research facilities. Chapter eight examines the growing practice of some universities to secure funding for research facilities by appealing directly to Congress and bypassing the peer review process. Finally, chapter nine, outlines the implications inadequate research facilities may have for graduate and undergraduate education at the Nation's universities.

## CHAPTER II. CONGRESSIONAL ISSUES: OPTIONS FOR ACTION

The current state of university research facilities raises several potential policy concerns for Congress. Essentially these policy concerns center around the following set of questions:

1. What should be the ongoing Federal role in assisting with the funding of university research facility construction activities?
2. Do the data contained in NSF's Doctoral Granting survey adequately portray the level of need required to elevate university research facilities to world-class-levels?
3. Is the traditional peer review process appropriate for determining which facility projects should receive Federal funding?
4. What are appropriate measures to determine the extent to which outdated university research facilities threatens America's ability to compete on an international basis with other technologically advanced nations?

There is general agreement in the academic community, though not necessarily within the Federal Government, that the current Federal approach of using individual-investigator grants as the primary mechanism to ensure an adequate research facility base is not realistic. The universities recognize that funding for university research facilities will have to come from a variety of different sources, including the Federal Government. For the period following World War II, the Federal Government traditionally, directly supported 65 percent of the cost of instrumentation and 20 percent of the cost of R&D plant. This policy changed in the late 1960s primarily because of controversy over grants to church-related universities and difficulties in coming up with a geographically equitable distribution of grants. Critics contend that the current level of Federal support is not adequate. The basic questions are : What is the proper Federal role? What are the different mechanisms through which the Federal Government can carry out that role? Are the current levels of Federal support appropriate? To address these questions it might be helpful to review different mechanisms the Federal Government might utilize to assist universities in meeting the research facilities needs.

A number of university officials, for example, have recommended that Congress establish a separate budget category for university research facilities funding. They contend that the cost of constructing and maintaining research facilities should be entirely separate from budget categories associated with Federal support for university research and development. Linda S. Wilson commented on the current Federal approach:

> As the project system now operates, firm commitments of support are rarely given for longer than one year, and planned commitments are often given for only three years, rarely for more than five years. The system requires accountability by discrete project. Neither of these features ideally ensures adequate infrastructure. Both approaches encourage narrow focus and short-term effectiveness; infrastructure requirements are usually broad and long term.[13]

The University Research Facility Revitalization Act of 1985 (H.R. 2823), introduced by former Congressman Don Fuqua, is one approach the university community believes should receive congressional support. The academic community believes passage of a bill similar to Fuqua's proposal would re-establish direct congressional responsibility for helping to maintain and update the Nation's university research facilities. The intent of Mr. Fuqua's bill recognized the long term nature of the facilities problem; it would have provided up-front capital many universities do not have access to; it required matching funds from non-Federal sources; it gave the six major Federal R&D agencies legislative authority to fund facilities projects; (only NIH had such authority) and it required peer review for all university requested facilities projects.

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[13] Wilson, p. 123.

The major concern for Congress is how to fund such a program. In general the university research community does not want to see research funds sacrificed to support a Federal facilities program. Nevertheless, Congress must make spending choices among many worthwhile programs, but it may not be possible to fund both because of current budget constraints.

Another approach supported by some university officials is the establishment of an independent nonprofit corporation to provide low-rate loans, loan guarantees, and other financial assistance to universities for facilities construction. Congress has already passed a similar proposal when it created the College Construction Loan Insurance Association (CCLIA). The major concerns the academic community has with the CCLIA, is that it targets universities that are "non-i3nvestment grade,"[14] and that the current $50 million annual funding level is inadequate. University representatives believe all academic institutions should be eligible to participate and that Congress should consider a one time Federal appropriation of perhaps $500 million in order to leverage a pool of money large enough to meet the requirements of all universities. However, the results of NSF's Doctoral Granting Survey may justify congressional support of a targeted facilities program. The survey indicated that the top 50 R&D schools account for over 60 percent of all planned construction activities between 1987 and 1991.

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[14] Investment Grade refers to an academic institution's level of credit calibre. Universities classified as "non-investment grade" are considered poor credit risks and may not be able to borrow capital for facilities activities.

These two approaches loom more important in light of the recently passed tax law, which could reduce access of private universities to up front capital necessary to begin facilities construction. Congress may wish to examine whether the capping of tax-exempt bonds and subjecting certain categories of private donations to universities to minimum taxation may eventually place private universities at an unfair disadvantage in trying to compete with the public universities for Federal research dollars. Private universities, over the next five years, are planning to fund 81 percent of their future facilities projects with tax-exempt bonds and private donations/endowments, (tax-exempt bonds 32 percent and private giving 49 percent) up from 42 percent of current facilities funding.[15]

Congressional consideration of re-establishing a major Federal role to support research facilities would probably raise the question of how such a program would be administered. Congress could consider a number of approaches. However, most of the facilities reports support either a centralized or decentralized approach.

Those recommending a centralized approach have suggested that NSF be the coordinating agency. They point out that NSF has a long and close working relationship with the academic community, a history of managing similar programs (e.g., past facilities programs and its current instrumentation program) and strong support for the peer review process. A decentralized approach would place responsibility for supporting a facilities program with each of the six major Federal R&D agencies. Those who support this approach contend, that besides just supporting basic research, NSF research interests are too narrow for such agencies as DOD and DOE. Congress may wish to request that OSTP coordinate such a program since it already works with the six major research agencies on a variety of different programs.

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[15] NSF's Doctoral Granting Survey, p. 17.

Many in the academic community believe that Congress should raise the current use allowance rate for research facilities from 2 percent to 5 percent per year.[16] Primarily because university research administrators argue that the useful life span of a research facility is now closer to 20 years, rather than the 50 years the current use allowance rate acknowledges. This adjustment could possibly provide universities with additional sources of revenues necessary to help pay off their current and future facilities related debt, such as tax-exempt bonds.

It now appears that NSF's doctoral granting survey may have raised as many questions as it answered. Individual analysts and numerous educational associations argue that Congress should request that NSF obtain an independent analysis of its next facility survey questionnaire, which is currently being prepared for NSF's 1988 facilities report to Congress. The major purpose of such an analysis would be to determine if the survey is adequately designed to provide reliable information on the current condition of university research facilities. The review would also examine the extent to which the questionnaire will provide information on how well universities are capable of meeting their research facility needs. Some members of the academic community also believe NSF's survey would be a much more reliable instrument if they had an opportunity to make suggested revisions in the survey as well.

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[16] Use allowance or depreciation is compensation for the use of an institution's buildings and equipment when conducting federally sponsored research, provided the facilities are used for institutional activities and are properly allocable to sponsored agreements.

If Congress were to re-establish a university research facilities program, a major question that would have to be addressed is: what kind of peer review system should be established to award Federal facility funds? Are new mechanisms required to establish priorities to allocate resources for the costs of research, including the costs of providing research facilities? The University Research Revitalization Act of 1985 states funds should be awarded on a "competitive basis," utilizing three criteria:

1. The quality of the research and training to be carried out in the facility;
2. The congruence of the institution's research activities with the future research mission of the awarding agency; and
3. The contribution which the project will make toward meeting national, regional, and State research and related training needs.

If a decentralized facility program were endorsed, each agency could convene various peer review panels of experts to help meet requirements one and two. If a centralized Federal facilities program, directed by NSF was operating then NSF would probably be able to convene various peer review panels. However, instituting a peer review system that incorporates a systematic assessment of national needs is a much more challenging task for Congress. One approach that might be considered is for Congress to ask such organizations as the

National Academy of Sciences or the National Science Board to sponsor series of meetings or workshops in order to establish priorities for national research facilities in various fields of science.

Ultimately, no matter what peer review process emerges, the university community has to recognize that a facility peer review process can only provide, at best, a very general evaluation of the potential for quality research to be performed in a particular facility. This was acknowledged by those university representatives who introduced the concept of "comprehensive merit review," when they stated that the

> . . . allocation process for research facilities is not exclusively the result of a competition among proposals for identical facilities . . . the process is the result of an evaluation on a case-by-case basis of technical merit, local capabilities and aspirations, and other factors . . . social, economic, and political.

Congress also may wish to examine further the effect outdated university research facilities may be having on the ability of the Nation's universities to produce top quality scientists and engineers. Concomitantly, Congress might want to further investigate if universities are currently being forced to foreclose on promising lines of scientific investigations due to inadequate research facilities, as some have asserted.

## CHAPTER III. EXECUTIVE SUMMARY

This chapter presents highlights of the major findings of the different research facilities reports (listed in Appendix A) reviewed for this study regarding the current condition of university research facilities.

### FEDERAL FUNDING

o Funding for major Federal programs for construction of university research facilities declined 85 percent in constant dollars between FY 1963 and FY 1984.

o The two largest federally sponsored research facilities programs were the NSF's Graduate Research Facilities Program and NIH's Health Research Facilities Program.

o Direct grants for graduate facilities ended in 1969 and for undergraduate facilities in 1973. In addition, more than 88 percent of Federal funds for direct loans for facilities construction was appropriated prior to 1970.

o Federal funding for university research facilities dropped in the late 1960s primarily because the Federal Government shifted its funding away from institutional facilities support, to providing financial aid to individual students.

o In 1981, the Association of American Universities reported that academic institutions were able to address only 50 percent of the needs to renovate and modernize their research facilities.

o Direct Federal outlays for R&D plant, as a percentage of total Federal R&D, have declined from nearly 7 percent of the total in 1965 to less than 1 percent in 1983.

o A more recent and controversial source of Federal funds for facilities has come from various universities obtaining earmarked congressional appropriations (see Appendix E for list of such universities) for the construction or rennovation of their research facilities. In FY 1987, congressionally earmarked funds for university research facilities totaled approximately $145 million.

o Besides directly sponsoring Federal programs aimed at helping universities finance their facilities needs, over the past 40 years, the Federal Government has initialed a number of different mechanisms to help universities finance their facilities. These include, indirect cost recovery to universities in performing Federally sponsored research; tax incentives, such as individual and corporate deductions for charitable gifts to universities; and university access to the tax-exempt bond markets (see chapter VII); and the direct earmarked funding, from the Congress, (see Chapter VIII) for university research facilities.

o There is general agreement in the academic community that the current Federal approach of using individual investigator grants as the primary mechanism to insure an adequate research infrastructure is fundamentally flawed.

o NSF data and different facility surveys indicate that the majority of capital for construction and renovation of university research facilities has always been from non-Federal sources.

o There is consensus among University representatives that a number of different funding strategies, involving Federal, and State governments, industry, and the universities themselves, will be required if the Nation's universities are to successfully finance their current and future research facility needs.

o Despite strong protests from a number of higher educational organizations, congressional earmarking, for funding of specific university research facilities construction and renovation continues to grow.

## FEDERAL LEGISLATION

o The National Cancer Institute Act of 1948, was the first post-World War II Federal statutory authority for financing construction as well as alterations and renovation of academic and related facilities at higher education institutions (42 USC 285). The Act also required "appropriate review for scientific merit and recommendation for approval by the National Cancer Advisory Board." (42 USC 286)

o Title VII of the Higher Education Act (HEA) of 1986 (P.L. 99-498) provides $25 million in grants for construction, reconstruction and renovation of undergraduate and graduate facilities. The upgrading deemed necessary by an institution must ". . . be essential to the continued utility of the research or instructional instrumentation and equipment."

o Section E of Title VII of the HEA authorizes the formation of the College Construction Loan Insurance Association, a partnership between the Federal Government, the private sector and interested institutions, to enhance the creditworthiness of colleges, in order to finance different construction activities.

o The Food and Security Act of 1985 (P.L. 99-198) establishes a new grant program for the 1890 land-grant institutions to upgrade their extension facilities. The Act provides $10 million for each of the fiscal years 1986 through 1990 for the purpose of assisting in the purchase of equipment and land, and the planning, construction, alteration or renovation of buildings.

o Provisions are contained in the Tax Reform Act of 1986 (P.L. 99-154) that will have a significant impact on colleges and universities. Of particular concern is that the legislation imposes a ceiling of $150 million on the amount of tax exempt bonds which any private institution of higher education could have outstanding at one time. Another major concern is that the repeal of the investment tax credit and the reduced depreciation allowance for companies might weaken the incentive for companies to invest in higher education.

o The University Research Facilities Revitalization Act of 1985, H.R. 2823, was introduced in the 99th Congress. Provisions within the legislation would authorize $10 billion over a 10-year period for the replacement or modernization of university or college obsolete laboratories and other research facilities ($5 billion in Federal funds redirected from elsewhere in the Federal R&D budget, and $5 billion in matching non-Federal funds).

o On April 1, 1987, Representative Robert A. Roe, chairman of the House Science, Space and Technology Committee introduced H.R. 1905 to assist in revitalizing the Nation's academic research programs. The proposed legislation would authorize the National Science Foundation (NSF) to spend $250 million per year, for the next ten years for the repair, renovation, or replacement of laboratories and other facilities at colleges and universities.

## NSF'S SURVEY OF DOCTORAL GRANTING INSTITUTIONS

- According to NSF's survey on Science and Engineering Research Facilities at Doctorate-Granting Institutions, in the academic year 1985-1986, the estimated costs to complete all facilities related construction work, including major repairs, upgrading and renovation, and new construction was $1.7 billion. The costs to complete work planned between 1986 and 1991 was estimated to be $5.8 billion. The top 50 R&D schools accounted for over 50 percent of the costs of total work in progress and over 60 percent of the estimated costs for planned work.[17]
- A majority of research administrators and deans did not believe the: "inability to obtain loans, restriction on the use of endowments and grants, legal restrictions, lack of campus space, and pressure to develop teaching rather than research capabilities, constrained their university from addressing its facility needs."[18]
- NSF's Doctoral Granting Survey estimated that the Federal Government now funds about 10 percent of the costs of facility construction and renovation, but is expected to provide only 6 percent of the total costs by 1991.
- The major sources of funds for research facility construction are State governments, and private donations and endowments, with

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[17] According to NSF the "Top 50" are the top 50 universities ranked in terms of Federal research and development expenditures in 1985.

[18] NSF Doctoral Granting Survey, p. 25.

public institutions relying primarily on the former and private institutions relying on the latter.

- The top 50 R&D schools were spending more than twice as much for both upgrading and renovation and major repairs, as those institutions below the top 50.
- Eighty-nine percent of research administrators report that the number of research projects at their universities are limited by facilities, and 92 percent indicated that the type of research project undertaken is facilities limited.
- Forty-two percent of the top 50 R&D schools list facilities limitations as their most pressing research related need.
- Ninety-five percent of the research administrators said they had less space than they needed, while 75 percent stated that additional research space was more critical than repairing or upgrading existing space.
- Approximately one-third of the research administrators and deans ranked facilities as the major problem facing research in the next five years: by fields of science physical sciences (59 percent), environmental science (47 percent), engineering (38 percent), medical sciences (36 percent), computer sciences (35 percent), and life sciences (33 percent).
- Forty-eight percent of research administrators rated their current research space as good to excellent, while 49 percent indicated their current space was fair to poor.
- In general, the university community has been critical of NSF's Doctoral Granting Survey. Essentially, they contend NSF's report to Congress tended to accentuate the positive aspects of the data, while underplaying the data's negative implications.

## IMPACT ON EDUCATION

- Different analysts contend that perhaps the most serious impact of inadequate research facilities is that many universities are not able to recruit and retain the most productive faculty members and outstanding graduate students. Many universities have lost such people to private industry because of outdated research facilities.
- Nearly all of the analysts and reports assessing the quality of the Nation's research facilities suggest that these facilities are in such poor condition that they undermine the universities' ability to carry out successfully their primary responsibilities of teaching and conducting research.
- These same studies suggest that the current conditions of research facilities may have serious implications for the quality of future scientists and engineers produced by the Nation's universities.

# CHAPTER IV. INITIAL GROUNDBREAKING: PAST AND CURRENT FEDERAL R&D FACILITIES PROGRAMS

## INTRODUCTION

This chapter of the report provides a brief historical overview of Federal funding for university research facilities. Current initiatives of the National Science Foundation (NSF) and National Institutes of Health (NIH) programs are discussed, along with other smaller past facilities activities sponsored by the Department of Defense (DOD), the Atomic Energy Commission (AEC)/ Department of Energy (DOE), the National Aeronautics and Space Administration (NASA), and the U.S. Department of Agriculture (USDA).

Funding for major Federal programs directly supporting construction of university research facilities declined 85 percent in constant 1982 dollars between 1963 and 1984. The two largest programs were the National Science Foundation's Graduate Research Facilities Program (1960-1970) and the National Institutes of Health's Health Research Facilities Program (1957-1972) discussed on p. 22-23. NSF's survey of Federal Support for research facilities as discussed in a General Accounting Office report,[19] indicates that much of the decline began around 1969 and 1970 when direct Federal funding for facilities construction began to decrease because of the Government's shift toward other priorities.

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[19] U.S. General Accounting Office. University Funding: Federal Funding Mechanisms in Support of University Research. Report to the chairman, Committee on Science and Technology, [U.S.] House of Representatives. Feb. 1986. GAO/RCED-86-53, p. 44.

## TRENDS IN R&D FACILITIES FUNDING

The focus of this report is facilities, which consists of the actual buildings, laboratories, machine shops, and specialized technical operation facilities designed to accommodate and maintain research projects. Also, facilities involves (as the NSF definition for R&D plant indicates) the acquisition, renovation, modification, repair, and rental of buildings, land, works, or equipment for use in scientific or engineering research and development. By contrast, instrumentation includes the equipment and devices directly supportive of data acquisition and analysis.

The passage of the National Defense Education Act (NDEA) in 1958 marked a significant turning point in the relationship between the Federal Government and American higher education. The decade following the passage of the NDEA witnessed a steady stream of Federal legislation that expanded and redefined the relationship between the Federal Government and the higher education community.[20]

In December of 1963, President Johnson signed the Higher Education Facilities Act of 1963 into law. The new law provided for: 1) physical plant construction aid in the form of facilities for engineering, and library buildings; 2) a student loan program; and 3) grants to States for construction of community colleges, limited to science, engineering, and library buildings.[21] Many educators believed that the passage of the facilities act, without any "national defense" overtones, represented a Federal recognition of the value of supporting higher education for its own sake.

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[20] Wilson, John T. Academic Science, Higher Education and the Federal Government 1950-1983. The University of Chicago Press. p. 47.

During the 1960s, President Johnson made education a top social issue. One of the President's major objectives was to ensure that the Federal Government help provide greater access to a college education for individuals from all levels of our society. He said:

> I believe every child has the right to as much education as he has the ability to receive. I believe this right does not end in the lower schools, but goes on through technical and higher education-if the child wants it and can use it.[22]

Following this policy pronouncement, the Nation's universities and colleges turned to the Federal Government as a major source of funding for constructing various facilities to accommodate the large influx of college students in the 1960s. One mechanism used by the Federal Government to help universities and colleges with facilities funding were unrestricted institutional grants. As this chapter points out, however, both NIH and NSF provided institutional grants to the Nation's universities that were limited to the general support of science, including the construction of research facilities.

Between 1963 and 1967 funding for university research facilities remained stable, but with the election of President Richard M. Nixon, the Federal Government began shifting away from the support of institutional grants. Instead, the Federal Government focused its energies on providing aid to individual students. There were two major reasons for this policy shift. First, Federal institutional grants to private church-related universities raised serious constitutional questions regarding separation of church and State. And second, the inability of the higher education community to agree on an equitable geographical distribution of institutional grants, played a major role in Congress deciding to utilize individual student aid as a way to support higher education.[23] One of the major fallouts of this policy was a dramatic decline in direct Federal support for the construction of university research facilities.

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[21] Ibid., p. 48.

[22] Ibid., p. 49.

For example, between FY 1963 and FY 1984, overall direct Federal funding for the construction of university and college research facilities showed a marked decline in both current and 1982 constant dollars (see table 4.1 and figure 4.1 for comparisons of current and 1982 constant). Total Federal obligations to universities and colleges for these purposes decreased from $325.0 million (all figures are in constant dollars) in FY 1963 to $45.9 million in FY 1984, an 85 percent decline in current and constant dollars.[24]

In FY 1965 Federal funding levels for facilities peaked at $373.9 million, and steadily declined to a low of $68.4 million in FY 1971. In FY 1972 funding increased to $80.1 million and climbed further again in FY 1973 to $89.5 million. By FY 1976, however, funding for facilities hit an all-time low of $38.4 million. Federal funds for facilities increased between FY 1982 and FY 1984 from $31.2

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[23] Ibid., p. 59.

[24] Source used for all subsequent information about R&D plant funding was taken from the NSF report, Federal Support to Universities, Colleges, and Selected Nonprofit Institutions, Fiscal Year 1984. Surveys of Science Resources Series, Detailed Statistical Tables, p. 18-19.

TABLE 4. Trends in Direct Federal Funding for Construction of University Academic Facilities, By Selected Agencies
(Constant 1982 $) *
(Dollars in Millions)

| | Total, All Agencies | USDA | DOD | DOE | HHS | NASA | NSF |
|---|---|---|---|---|---|---|---|
| 1963 | $325.0 | 0.0 | 0.0 | 7.9 | 120.3 | 41.1 | 155.3 |
| 1964 | 306.9 | 0.0 | 3.0 | 12.1 | 120.7 | 27.5 | 144.6 |
| 1965 | 373.9 | 9.5 | 0.0 | 11.2 | 162.3 | 24.8 | 165.9 |
| 1966 | 330.4 | 5.7 | 0.0 | 21.3 | 139.6 | 21.3 | 141.9 |
| 1967 | 309.7 | 5.5 | 0.0 | 38.4 | 106.0 | 13.9 | 145.0 |
| 1968 | 258.4 | 5.1 | 0.0 | 31.9 | 99.2 | 0.0 | 121.8 |
| 1969 | 139.0 | 3.0 | 0.0 | 29.0 | 52.2 | 0.0 | 54.5 |
| 1970 | 108.0 | 2.6 | 0.0 | 17.1 | 48.2 | 0.0 | 39.7 |
| 1971 | 68.4 | 0.0 | 0.0 | 10.9 | 34.8 | 0.4 | 22.2 |
| 1972 | 80.1 | 0.0 | 0.0 | 8.9 | 48.1 | 1.3 | 21.7 |
| 1973 | 89.5 | 0.0 | 0.0 | 11.5 | 55.2 | 6.2 | 15.3 |
| 1974 | 55.5 | 0.0 | 0.0 | 8.0 | 27.7 | 0.1 | 19.5 |
| 1975 | 77.8 | 0.0 | 0.0 | 7.3 | 39.8 | 0.1 | 30.5 |
| 1976 | 38.4 | 0.0 | 0.0 | 9.0 | 18.3 | 0.1 | 9.5 |
| 1977 | 54.4 | 0.0 | 0.0 | 26.1 | 16.5 | ** | 10.8 |
| 1978 | 47.8 | 0.0 | 0.0 | 18.6 | 13.8 | 0.0 | 15.3 |
| 1979 | 41.2 | 0.0 | 0.0 | 11.6 | 9.6 | 0.2 | 18.8 |
| 1980 | 44.6 | 0.0 | 0.0 | 24.3 | 5.1 | 0.2 | 14.8 |
| 1981 | 29.7 | 0.0 | 1.1 | 21.0 | 2.1 | 0.1 | 5.2 |
| 1982 | 31.2 | 0.0 | 0.5 | 18.8 | 5.4 | 0.2 | 4.9 |
| 1983 | 35.9 | 9.2 | 0.0 | 16.4 | 1.4 | 1.4 | 7.3 |
| 1984 | 45.9 | 8.8 | 0.0 | 27.2 | 0.6 | 0.2 | 8.9 |

* Calculated by CRS using figures from Table B-2 Federal Academic Science/Engineering Obligations to Universities and Colleges by Type of Activity and Agency: FY 1983-84. In NSF report, Federal Support to Universities, Colleges, and Selected Nonprofit Institutions, Fiscal Year 1984, p. 19. The table does not include indirect Federal funding, tax subsidies, and direct congressional appropriations.

** Amount less than $50,000.

million to $45.9 million. Such funding levels reflect a reversal in trends that may be welcomed by university research officials.

Most agency facilities funding levels have declined drastically since FY 1963 as table 4.1 indicates. NSF funding levels have decreased from an all-time high of 165.90 million in FY 1965 to $8.9 million in FY 1984, and all-time low of $4.9 million in 1982.

The Department of Health and Human Services funding level in FY 1963 was $120.3 million, but increased to an all-time high of $162.3 million in FY 1965, only to decline to a low of $0.6 million in FY 1984.

The National Aeronautics and Space Administration's funding levels have decreased from $41.1 million in FY 1963 to $0.2 million in FY 1984.

The data in table 4.1 shows that the U.S. Department of Agriculture's FY 1965 funding level for facilities construction activities was $9.5 million. After declining to $2.6 million in FY 1970 such funding was eliminated until FY 1983 when facilities support reached $9.2 million.

As indicated in table 4.1, the Department of Defense did not research facilities activities until FY 1981 when 1.2 million was awarded. The only other funding, of $0.5 million, was allotted in FY 1982.

In addition, table 4.1 indicates that between FY 1963 and 1964, the Department of Energy's funding levels increased. In FY 1963, the funding level was $7.9 million. By FY 1977, funding rose to $26.1 million and climbed further to an all-time high in FY 1984 of $27.2 million.

## A BRIEF SUMMARY OF PAST AND PRESENT FEDERAL FACILITIES PROGRAMS AT UNIVERSITIES

The following section presents a detailed analysis and funding history of the Higher Education Facilities Act of 1963 and its numerous amendments.

### The Higher Education Facilities Act

As discussed earlier, the Higher Education Facilities Act of 1963 (P.L. 88-204), provided statutory authority for construction of academic facilities. It authorized assistance to public and other nonprofit institutions of higher education in financing the construction, rehabilitation, or improvement of needed academic and related facilities in undergraduate and graduate institutions.

Under Title I, Sec. 103 (a), "Allotments to States for Public Community Colleges and Public Technical Institutes," funds are allotted to States to be used in providing academic facilities for public community colleges and public technical institutes.

Sec. 106, "Eligibility of Grants," indicates that an institution of higher education, other than a public community college or public technical institute is eligible for a construction grant for an academic facility only if such construction is limited to structures, or portions thereof, especially designed for instruction or research in the natural or physical sciences, mathematics, modern foreign languages, engineering, or for use as a library. This restriction was eliminated through the Higher Education Facilities Act of 1965. Also, the Federal share was changed from a fixed rate of 40 percent to a rate not to exceed 40 percent.

In 1966, the Act was further amended to ensure that such facilities would be constructed for the accessibility and useability by handicapped individuals, in compliance with standards prescribed or approved by the Secretary of Health, Education, and Welfare.

Again in 1968, the Act was further reauthorized to be extended through the end of FY 1971. The eligibility for construction grants was broadened to cover construction of needed health care to students or personnel of the institution. Sec. 107 (b), "Basic Criteria for Determining Priorities and Federal Share," states that in case of a project for an institution of higher education other than a public community college or public technical institute, the Federal share shall not exceed 33 $^1/3$ percent of its development cost, and in the case of a project for a public community college or public technical institute, the Federal share shall be 40 percent of its development cost. In 1968, amendments to this section increased the Federal share to 50 percent of the development costs for institutions other than a public community college or technical institute, and for a public community college or public technical institute construction project.

Amendments to the Act in 1965, 1966, and 1968 reauthorized appropriations through the end of FY 1968 to extend grants for the construction of graduate academic facilities and loans for construction of applicable academic facilities. The Education Amendments of 1972 (P.L. 92-318) transferred the provisions of the Higher Education Facilities Act (HEFA) of 1963 to title VII of the Higher Education Act of 1965. In FY 1973, the last construction grants were awarded.[25] The HEFA program was administered by the

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[25] For additional information concerning further amendments to the Higher Education Facilities Act, see chapter 3 of this report.

Office of Education within the former U.S. Department of Health, Education, and Welfare.

Through the Education Amendments of 1976, title VII of HEFA was named "Construction, Reconstruction, and Renovation of Academic Facilities." Technical changes in the definition of the term "construction" were made and emphasis was placed on "conservation of energy resources, removal of architectural barriers, environmental protection, research facilities and special research equipment, and removal or containment of asbestos hazards."[26]

> The Education Amendments of 1980 (P.L. 96-374) authorized the use of construction funds for the removal or containment of asbestos hazards and the removal of architectural barriers for the handicapped, . . . restricted the use of funds to alleviating existing shortages of facilities (rather than projected or planned increases in capacity), and required that all Title VII program objectives have equal funding priority.[27]

In 1981, the Omnibus Budget Reconciliation Act prohibited appropriations for construction grants from FY 1982 through FY 1984.[28]

Under part A of title VII, as table 4.2 indicates, $300 and $100 million, respectively, were authorized at various times for construction grants for undergraduate academic facilities since FY 1974. No monies, however, have been appropriated for this purpose since FY 1973. Similarly, under part B of title VII, authorizations for construction grants for graduate academic facilities also have been made but no appropriations were granted between FY 1971 and FY

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[26] U.S. Congress. Senate. Committee on Labor and Human Resources. Reauthorization of the Higher Education Act: Program Descriptions, Issues, and Options. Prepared by the Congressional Research Service. Library of Congress. Washington, U.S. Govt. Print. Off., 1985. p. 279.

[27] Ibid., p. 282.

[28] Ibid.

1982. (See table 4.3.) Congressionally earmarked funding for FY 1983 was to be spent only for the Center for Advanced Technology at the University of New Hampshire and the Central Library at Boston University. Again, in FY 1984 no funding was appropriated for academic facilities construction. In FY 1985, however, $28 million was made available for both undergraduate and graduate facilities apparently rescinding the authorizing statute that stipulated funding use for graduate facilities only.[29]

Part C of title VII authorizes different kinds of loan provisions for academic facilities "to assist institutions in meeting unusual increases in enrollments and to support and expand the Nation's research facilities." Non-Federal sources must finance at least 20 percent of the total project costs. Since FY 1965, 660 institutions have received about $680 million in loan support through a revolving fund provided under part C. Only four new loans have been provided, however, since FY 1975 and all were initiated by Congress.

## FACILITIES PROGRAMS SPONSORED BY FEDERAL R&D AGENCIES

During the 1960s, a number of Federal R&D agencies sponsored different programs aimed specifically at helping universities build or renovate their research facilities. The following section of this chapter presents a brief review of past and current facilities programs supported by various Federal R&D agencies.

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[29] Ibid., p. 284.

TABLE 4.2. Appropriation History for Construction Grants for Undergraduate Academic Facilities, Currently Authorized under Part A of Title VII of the Higher Education Act (in millions)

| Fiscal Year | Authorization | Appropriation |
|---|---|---|
| 1964 | $230 | -0- |
| 1965 | 230 | $230 |
| 1966 | 460 | 458 |
| 1967 | 475 | 453 |
| 1968 | 728 | 400 |
| 1969 | 936 | 83 |
| 1970 | 936 | 76 |
| 1971 | 936 | 43 |
| 1972 | 50 | 43 |
| 1973 | 200 | 43 |
| 1974 | 300 | -0- |
| 1975 | 300 | -0- |
| 1976 | 300 | -0- |
| 1977 | 300 | -0- |
| 1978 | 300 | -0- |
| 1979 | 300 | -0- |
| 1980 | 300 | -0- |
| 1981 | 100 | -0- |
| 1982 | 100[a] | -0- |
| 1983 | 100[a] | -0- |
| 1984 | 100[a] | -0- |
| 1985 | 100 | -0- |
|  | 1964-1985 Total - | $1,829 |

[a] P.L. 97-35 prohibited appropriations for part (graduate facilities) of title VII for FY 1982 through FY 1984.

Source: U.S. Congress. Senate. Committee on Labor and Human Resources. Reauthorization of the Higher Education Act: Program Descriptions, Issues, and Options. Prepared by the Congressional Research Service. Library of Congress. Washington, U.S. Govt. Print., Off., 1985. p. 283.

TABLE 4.3 Appropriation History for Construction Grants for Graduate Academic Facilities, Currently Authorized under Part B of Title VII of the Higher Education Act (in millions)

| Fiscal Year | Authorization | Appropriation |
|---|---|---|
| 1964 | $25 | -0- |
| 1965 | 60 | -0- |
| 1966 | 120 | $60 |
| 1967 | 60 | 60 |
| 1968 | 120 | 60 |
| 1969 | 120 | 50 |
| 1970 | 120 | 8 |
| 1971 | 120 | -0- |
| 1972 | 20 | -0- |
| 1973 | 40 | -0- |
| 1974 | 60 | -0- |
| 1975 | 80 | -0- |
| 1976 | 80 | -0- |
| 1977 | 80 | -0- |
| 1978 | 80 | -0- |
| 1979 | 80 | -0- |
| 1980 | 80 | -0- |
| 1981 | 80 | -0- |
| 1982 | 80[a] | -0- |
| 1983 | 80[a] | 22.5[b] |
| 1984 | 80[a] | -0- |
| 1985 | 80 | 28 |
| | 1964-1985 Total = | $288.5 |

a/ P.L. 97-35 prohibited appropriations for part B of title VII for FY 1982 through FY 1984.

b/ Funds were required to be spent only for the Center for Advanced Technology at the University of New Hampshire and the Central Library at Boston University.

National Science Foundation

Between 1960 and 1972, the National Science Foundation (NSF) initiated and conducted many institutional facilities construction and renovation programs to enhance research and education in various colleges and universities across the Nation. The programs were carried out under a directorate headed by an Assistant Director for Institutional Programs. The first of such programs, discussed below, was called the Graduate Research Laboratory Development Program, later redesignated as the Graduate Science Facilities Program (GSF). Initially, because of a small budget, the program emphasized renovation instead of new construction. Later, as funding levels increased, more money was used for new construction projects.

The GSF received a $2.0 million budget in FY 1960. It was necessary for participating universities to contribute 50 percent in matching funds to be eligible to participate in the program. Also, the program was restricted to universities that offered doctoral work in science and engineering and to laboratories that conducted basic research.

In FY 1962, the GSF program was expanded to include institutions offering the master's degree as their highest degree awarded. In addition, the institution was permitted to spend up to 10 percent of the grant money for general-purpose laboratory equipment. In FY 1963, an NSF report states, "86 percent of the grant money was used for new construction. . . ." In addition, the average grant was slightly more than $200,000, and seven universities received grants of $1.0 million or more.[30] In FY 1964, funding peaked to $30.5 million and gradually declined to $4.0 million by FY 1970. During the 11-year period of the GSF program, $188.2 million was awarded in grants.[31]

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[30] National Science Foundation. NSF Institutional Programs, 1960-72. Unpublished report. p. 2.

[31] Ibid., p. 2. Also, FY 1970 figure noted from table I, Summary of GSF Proposals and Actions By Fiscal Year: FY 1960-1970.

Although the GSF program was terminated in FY 1970, NSF's Science Development program continued through FY 1972 providing funding for the building and renovation of university laboratories.

Initiated in 1964, the Science Development Grants (Centers of Excellence) was established to increase the number of institutions of recognized excellence in research and research education in the sciences. Universities received block grants awarded on a competitive basis, using the potential to develop research excellence as a primary criteria for the award; rather than the traditional criteria of existing research excellence of the $233 million dollars that was awarded to universities between 1964 and 1972, only 16 percent or $37 million was spent for facilities.[32]

Current Facilities Program

On September 27, 1985, Erich Bloch, NSF Director, announced NSF's policy on construction and renovation of research and education facilities is as follows:

> [P]rincipal responsibility for providing facilities for research and education remains with academic institutions. The Foundation will, however, consider limited support for facilities when a compelling case can be made.[33]

According to the notice that was given regarding this policy, currently, the Foundation's funds are constrained, and no new or special funds are expected to be available for facilities. In most disciplines, NSF plans to give consideration first to project support, then to major equipment and instrumentation, and then to facilities.

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[32] National Science Foundation Annual Report 1972. p. 82.

[33] National Science Foundation. Office of the Director. Important Notice to Presidents of Universities and Colleges and Heads of Other National Science Foundation Grantee Organizations. Policy on Construction and Renovation of Research and Education Facilities. Notice no. 98, Sept. 27, 1985. 1 p.

In areas in which research is especially dependent on specialized facilities, however, and a pressing argument is made that facilities are required in order to accomplish specific research or education objectives, facilities support will be provided.

## Department of Defense[34]

The Department of Defense (DOD) has maintained a strong relationship with the Nation's universities since before World War II. During and after the war, DOD helped to finance major expansion of research facilities at several universities. Among main recipients of DOD funding were the Massachusetts Institute of Technology (the MIT Lincoln Laboratory was built in 1952 through DOD funding), Harvard, Columbia, the University of Chicago, the University of California, the Johns Hopkins University Applied Physics Laboratory, the California Institute of Technology, the Applied Physics Laboratory of the University of Washington, the Applied Research Laboratories of the University of Texas, the Applied Research Laboratory of Pennsylvania State University, and the Marine Physical Laboratory, Scripps Institute of Oceanography, University of California, San Diego. However, by the late 1950s, with the ceasing of military conflict and broadening Federal support of university research facilities, the Department of Defense ended its facilities support.

Following World War II, permanent working plans for defense investment in university laboratory facilities were established. For example, "the institute concept became well established, wherein non-profit university affiliated laboratories conduct applied research, primarily under DOD support."[35] Facilities of this post war era which currently make major contributions, are Lincoln Laboratories at MIT, which was constructed through DOD funds in the Johns Hopkins University Applied Physics Laboratory.

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[34] All subsequent information regarding DOD was taken from the Department of Defense Report on Selected University Laboratory Needs in Support of National Security. Prepared for the Subcommittee on Research and Development of the Committee on Armed Services of the U.S. House of Representatives, Apr. 29, 1985. p. 6-7.

### Current Facilities Program

Recently, DOD contended that the department should not be involved in supporting facilities. The Pentagon contends that Federal law prohibits DOD from getting involved in the actual building of university research facilities. As far as it is known, DOD is not currently funding any facility construction programs at colleges and universities.

## Atomic Energy Commission/Department of Energy

In the early 1960s, the Atomic Energy Commission sponsored a "series of actions", to provide for or assist in the construction of specialized research facilities on various university campuses. Funding for the projects was provided usually through congressional mandates as budget-line items or costs were covered through a 10-year user fee.[36] Peer review regarding the feasibility of these projects did not occur.

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[35] U.S. Dept. of Defense. Selected University Laboratory Needs in Support of National Security. Prepared for the Subcommittee on Research and Development of the Committee on Armed Services of the U.S. House of Representatives. Apr. 29, 1985. p. 6.

[36] U.S. General Accounting Office. University Funding, p. 125.

Some examples of such actions include funding for construction of university accelerator facilities to build academic capabilities in nuclear science. No new construction for this purpose has occurred for 20 years. The Massachusetts Institute of Technology's Bates Linear Accelerator was built during the 1965-1972 time period. Through congressional action, AEC was budgeted $5.7 million for this project and MIT contributed $1.5 million. The current estimated replacement cost for this facility is over $60 million. Texas A&M's Cyclotron was funded in 1965 with a $1.0 million grant from the Welsh Foundation; $2.0 million from Texas A&M; and $3.0 million from AEC. Finally, Yale University's Heavy Ion Accelerator was built as a result of an additional congressional line-item to the AEC budget. Currently, it is no longer operating and has been dismantled.[37] These type of actions that are referred to as "direct appropriations or earmarked funding" which will be discussed in chapter VII of this report.

### Current Facilities Programs

Currently, DOE has not initiated any university facilities programs. All projects that were funded between FY 1984 and projected to be funded through FY 1989 were congressionally mandated, through direct congressional appropriations.

## Department of Health and Human Services (DHHS)

Since 1948, the Department of Health, Education and its successor DHHS has supported construction of health research facilities through various institutes within the National Institutes of Health (NIH). Initially, appropriations were made to the National Cancer Institute (NCI) and over the years, nine separate institutes have had authority to provide direct financial assistance for the construction, renovation, and/or replacement of health research facilities.[38] Currently, only three institutes continue to have such authority--The National Cancer Institute, the National Eye Institute (NEI), and the National Heart, Lung and Blood Institute (NHLBI).

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[37] Ibid., p. 127.

All programs established, except one have been specifically for construction, renovation, and replacement of cancer, eye or heart research facilities, mental retardation centers, primate research centers, medical library facilities, and others. The exception was the Health Research Facilities Act of 1956 that broadened funding authority to include "the construction, renovation, and replacement of non-federal health-related research facilities with no limitation as to areas of health-related research or type of facility."[39] This program is stated to have played a significant role in developing the Nation's biomedical research abilities.[40] Funding for the program ended in 1972 with a total funding effort of $535 million.[41]

Grants were used to fund nearly all construction projects. The Health Research Facilities Act required a 50/50 matching grant program between the Federal Government and the educational institution. In the construction of mental retardation centers and medical libraries, however, the Federal Government covered up to 75 percent of the costs.[42]

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[38] U.S. Dept. of Health and Human Services. Public Health Service. National Institutes of Health. Research Facilities, by Thomas E. Malone, Deputy Director, NIH. Feb. 1985. p. 2.

[39] Ibid., p. 3.

[40] Ibid.

[41] U.S. General Accounting Office. University Funding, p. 121.

Subsequently, however, funding to support construction became competitive with support for research funding because appropriations were not specifically earmarked for construction. As a result, the construction authority of NHLBI and NEI was not used. Also, a steady decline in the amount of NCI support for construction occurred.

## The National Cancer Institute (NCI)[43]

The National Cancer Act of 1971 established the cancer research facilities construction program at NCI.[44] According to a spokesman at NCI, all money allotted for construction purposes was for cancer research activities. The NCI Construction Program, is administered by the Research Facilities Branch of NCI which provides matching funds to grantee institutions.

From FY 1972 to 1978, NCI provided 75 percent of the costs for construction projects. The grantee institution had to provide 25 percent from non-Federal sources. In February 1978, this process changed with an agreement for 50/50 contributions from the agency and the grantee institution.

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[42] U.S. Dept. of Health and Human Services. Research Facilities, p. 2.

[43] All information, except the first sentence, received during a telephone conversation with a spokesman at NCI on May 13, 1986.

[44] Taken from unpublished paper entitled, "Facilities Funding Programs," p. 1.

From FY 1972 to FY 1984, NCI awarded 109 construction grants and funded $219 million in construction grant funds.

## The National Eye Institute (NEI)

Prior to FY 1982, NEI had not used its funding authority for construction of research facilities. In FY 1982, NEI awarded 14 grants for a total of $5.0 million to various universities for vision research facilities construction projects.[45]

## The National Heart, Lung, and Blood Institute (NHLBI)

The NHLBI has had the authority to expend funds and award grants for the construction of health-related research facilities since 1948. Fiscal Year 1985 was the first time NHLBI acted upon such authority.

### Current Facilities Programs

By 1985, a total of $882 million ($786 million in 1982 constant dollars) had been obligated by DHHS through NIH to fund major construction programs over its 36-year funding period. The largest amount (55 percent) was received by medical schools.[46] In FY 1985, NIH funded a total of $12.1 million through its extramural construction programs sponsored by the National Cancer Institute, the National Eye Institute, and the National Heart, Lung, and Blood

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[45] Information taken from a table (NEI Support for Construction Projects, Fiscal Years 1976 to Present, dated May 16, 1986) received from the National Eye Institute.

[46] Ibid.

Institute. The monetary breakdown for each institute is discussed below.

## National Cancer Institute

In FY 1985, NCI spent $5.5 million and awarded five grants through the NCI Construction program. The spending level for FY 1986 is unclear because of the possible impact of Gramm-Rudman-Hollings budget law. An estimate for FY 1987 has not been determined.[47]

## National Eye Institute

In FY 1985, NEI awarded 34 grants to various universities for construction of vision research facilities obligating, $3.3 million for the institute.[48]

## The National Heart, Lung, and Blood Institute

In FY 1985, the funding level, $3.3 million was awarded on a competitive basis to support alterations, renovations, and the establishment of modern research facilities relevant to the biomedical sciences and related to research activities in heart, lung, and blood diseases. Also, awards are issued on a matching basis. Eight universities were selected and allotted limited funding of $500,000 each for such construction.[49]

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[47] All information received during a telephone conversation with a spokesman at NCI on May 13, 1986.

[48] Information taken from Table 1, NIH Extramural Construction Obligations, FY 1948-1985, in the NIH report, Research Facilities, Feb. 1985.

[49] National Heart, Lung, and Blood Institute. National Institutes of Health. Announcement and Guidelines. Request for Applications: Alterations and Renovations to Establish NHLBI Shared Research Facilities. RFA-85-HL-26. Dec. 3, 1984. p. 1.

For fiscal year 1986, about $3.2 million was allotted for support of renovation and instrumentation projects as well as projects that were carried over from FY 1985.[50]

## National Aeronautics and Space Administration (NASA)

Between FY 1963 and FY 1968, NASA, through its facility grants program, funded a total of $43.3 million to award 37 grants to 34 academic institutions for the construction of research laboratories.[51] These facilities included Space Sciences Laboratories, Materials Research Centers, Biomedical Laboratories, and Propulsion Research Laboratories.[52] By the end of FY 1968, NASA's official university facilities grant program had been phased out.

### Current Activities

From FY 1972 through FY 1984, NASA has provided line-item funding for the construction of facilities, as was deemed necessary, in relation to research conducted towards the mission of the agency. NASA does not have a separate university facilities program at this time.[53]

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[50] Information received during a telephone conversation with a spokesman at NHLBI on July 29, 1986.

[51] National Aeronautics and Space Administration. Office of University Affairs. Research Facilities Grants. p. 39.

[52] U.S. Congress. Senate. Committee on Aeronautical and Space Sciences. Space Program Benefits: National Aeronautics and Space Administration. Hearings, 91st Cong., 2d Sess. Washington, U.S. Govt. Print. Off., 1970. p. 315.

[53] Current information received through a telephone conversation with an agency spokesman on Sept. 12, 1986.

## U.S. Department of Agriculture (USDA)

### USDA Agriculture Research Facilities Act

From FY 1963 to FY 1970, the USDA funded a formula grant program to all agricultural experiment stations to build facilities. The total funding level for the program was $10.2 million. The program has not been reactivated since 1970 when the last award was given. [54]

## Current Facilities Programs

### Cooperative State Research Service (CSRS)[55]

The CSRS supports a research facilities program designated for the 1890 Land-Grant institutions.[56] In FY 1981, Congress authorized a grant program through Agriculture and Food Act of 1981 (P.L. 97-98, Sec. 1433) to provide research facilities for 1890 Land-Grant colleges and Tuskegee University. The grant program was to extend over a five-year period at a funding level of $10 million per year for a total of $50 million. Through this authority such institutions can purchase land and equipment, plan, construct, alter, or renovate buildings to strengthen their research capabilities in the food and agricultural sciences. Fiscal Year 1983 was the first year that funding was appropriated for this program. Additional funding was provided for FY 1984, 1985, and 1986.

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[54] U.S. General Accounting Office. University Funding, p. 131.

[55] Information for this section was taken from a memorandum dated June 18, 1986 from the Acting Deputy Administrator of CSRS.

[56] In 1890, Congress passed the Second Morrill Act which required States with dual systems of higher education to provide land-grant institutions for blacks as well as whites. As a result, 16 black institutions were eventually established and designated as 1890 Land-Grant colleges.

The FY 1985 Farm legislation extended the research facilities program sponsored by the CSRS for 1890 Land-Grant institutions through FY 1987. Because of Gramm-Rudman-Hollings reductions however, the $10 million allotment as discussed above will be unavailable for FY 1987.

Also, CSRS is administering three additional grants. Through P.L. 99-190 (which provided FY 1986 continuing appropriations for the Agriculture, Rural Development, and Related Agencies Appropriations Act, 1986 and other such Acts) $596,400 was provided for a facilities planning grant to Tuskegee University and a $2.9 million planning grant to the University of Illinois. Also, through P.L. 98-151 (a continuing resolution of 1984) the University of Nebraska received $5.5 million to construct and equip a food processing transportation and marketing center, and $1.5 million to build a veterinary training facility.[57]

## CONCLUSION

Traditionally the Federal Government has not been the primary supporter of university research facilities. Nevertheless, during the 1960s, Federal support for research facilities often provided the necessary seed money to help universities acquire financing to expand their research facilities. This expansion was primarily a result of surging student enrollments in the mid-to-late 1960s. However, by the late 1960s, Federal policy shifted from supporting large institutional grants in favor of individual student support. Concomitantly, it appears as if policymakers during the Nixon administration, believed that the Federal Government had done more than its share of funding university research facilities. Consequently, beginning 1969, Federal direct funding for university research facilities experienced a significant decline that began to be restored in 1981.

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[57] Information taken from a memorandum dated June 18, 1986 from the Acting Deputy Administrator of CSRS.

In the 1960s, the majority of Federal research facilities funding was awarded through the different R&D agencies. Currently, the Federal Government is supporting a very modest research facilities effort. (In addition, congressional appropriations directed to specific universities are also supplying some facility funding as will be discussed below.) In FY 1985, Congress authorized the Department of Education to spend $28 million for research facilities, while in the same year, NIH spent only $12.1 million. Finally, in 1985 NSF announced it would provide limited support for universities research facilities, "when a compelling case could be made." However, at this time, NSF has not funded any facilities activities within this announced program.

# CHAPTER V. CONGRESSIONAL ACTIVITIES DURING THE 99th CONGRESS

## INTRODUCTION

The deterioration of the physical plant infrastructure has become a problem for colleges and universities, reportedly making it more difficult to maintain the quality of academic research and scientific education. Academic facilities, including research and instructional equipment, often have been neglected in order to support increased energy costs, faculty salaries, and student services. In testimony before the House Committee on Science and Technology, Donald N. Langenberg, Chancellor, University of Illinois at Chicago, cited a recent estimate reporting that approximately 50 percent of the physical plant of all universities and colleges is more than 25 years old, with 25 percent of that having been built prior to World War II.[58]

The Federal Government invested heavily in research facilities and equipment in the 1960s, but by the early 1970s, the expansion slowed and then fell off drastically. Direct grants for graduate facilities ended in 1969 and for undergraduate facilities in 1973.[59]

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[58] U.S. Congress. House. Committee on Science and Technology. The Federal Government and the University Research Infrastructure. Hearings, 99th Cong., 1st Sess., May 21, 22: Sept. 5, 1985. (Hereafter cited as the Federal Government and the University Research Infrastructure.) p. 207.

[59] U.S. Congress. House. Committee on Education and Labor. Higher Education Amendments of 1985. Report to Accompany H.R. 3700. House Report No. 99-383, 99th Cong., 1st Sess. Washington, U.S. Govt. Print. Off., 1985. p. 71. (Hereafter cited as Higher Education Amendments of 1985.)

In addition, more than 88 percent of Federal funds for direct loans to facilities was appropriated prior to 1970.[60] Loans that were made since 1970 were earmarked by Congress for specific institutions.[61] In 1981, the American Association of Universities reported that academic institutions were able to address only 50 percent of their needs to renovate and modernize their research laboratories.[62]

Though amounts vary widely as to the present deficits of physical infrastructure, the need for new and renovated research facilities is estimated to be measured in billions of dollars. In testimony before the House Committee on Science and Technology, Bernadine Healy, former Deputy Director, Office of Science and Technology Policy, estimated that the costs of renovating and modernizing the university research infrastructure over the next 5 years range from $5 to $20 billion.[63] Another reported estimate is that for all of postsecondary education, facilities and equipment renewal and replacement needs would range from $30 billion to $50 billion.[64] Yearly ongoing absolute maintenance needs have been estimated at $5 to $6 billion.[65]

Frank B. Sprow, Vice President, Exxon Research and Engineering Company, reported that current Federal support provides approximately 17 percent of the estimated $2 billion spent annually for equipment and facilities.[66] The scarcity of Federal resources has prompted some universities to bypass the traditional peer-review system and lobby congressional members directly for funds. This particular issue will be discussed later in this report.

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[60] Ibid.

[61] Ibid., p. 71.

[62] The Federal Government and the University Research Infrastructure, p. 207.

[63] Ibid., p. 3.

[64] Higher Education Amendments of 1985, p. 71.

[65] Ibid.

The present state of academic research facilities has evoked calls for Federal action from university officials and research directors. In response, members of Congress have proposed new legislation and amendments of existing laws aimed at providing funding for the renovation and construction of academic research facilities. This chapter summarizes legislative activities in the 99th Congress and selected policy alternatives for the support of research infrastructure of colleges and universities.

## LEGISLATION

The 99th Congress considered a number of bills to provide funding for construction and renovation of research facilities at colleges and universities. The legislative activities discussed in this section include the Higher Education Amendments Act of 1985 (P.L. 99-498), the University Research Facilities Revitalization Act of 1985 (H.R. 2823), the Health Research Extension Act of 1985 (P.L. 99-158), the High Technology Morrill Act (S. 935), the High Technology Research and Scientific Education Act of 1985 (S. 58, H.R. 1188), the Food Security Act of 1985 (P.L. 99-198), the Trade Development Investment Act (H.R. 4719), America's Living Standard Act of 1986 (S. 2810), the

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[66] The Federal Government and the University Research Infrastructure, p. 192.

Tax Reform Act of 1986 (P.L. 99-154), and the National Science Foundation Authorization Act for Fiscal Year 1986 (P.L. 99-159).

## Higher Education Amendments of 1986 (P.L. 99-498)

The Higher Education Act (HEA) of 1965 (P.L. 89-329, as amended) authorizes a broad range of Federal postsecondary education assistance programs for both students and institutions. Since 1965 the HEA has been the major legislative initiative for financial aid to postsecondary students and institutions. The 99th Congress considered and passed major amendments to the HEA, which are contained in the 1986 reauthorization legislation, the Higher Education Amendments of 1986 (P.L. 99-498). The new legislation extends and amends HEA programs for 5 years through FY 1991.[67] Though there are multiple issues and programs addressed by the 1986 HEA Amendments, this report will give attention to Title III - Institutional Aid and Title VII-Construction, Reconstruction and Renovation of Academic Facilities. Both titles contain provisions dealing with the financing of academic research facilities and the acquisition of special research equipment.

The HEA's program of construction and renovation of academic facilities has its legislative origins in the Higher Education Facilities Act of 1963, P.L. 88-204. The act responded to a large enrollment increase in the colleges and universities in the early 1960s which threatened to overwhelm their facilities. Since 1963, comprehensive legislation and numerous other statutes have amended portions of the HEA. For an analysis of the amendments and history of the legislation, see Reauthorization of the Higher Education Act: Program Descriptions, Issues and Options.[68] Following is a summary of the provisions of Title III and Title VII of the 1986 HEA. An analysis of the current legislation can be found in the CRS publication--Higher Education Act: Reauthorization Issues.[69] A comparison of the previous legislation and the current law is provided in Higher Education Daily - Special Supplement.[70]

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[67] U.S. Congress. House. Higher Education Amendments of 1986. Conference Report to Accompany S. 1965. House Report No. 99-861, 99th Cong., 2nd Sess. Washington, U. S. Govt. Print. Off., 1986. 475 p. (Hereafter cited as Higher Education Amendments of 1986.)

## Summary of Provisions

A brief description follows of the content of the two titles of the HEA about facility construction - Title III, Institutional Aid and Title VII, Construction, Reconstruction and Renovation of Academic Facilities.

### Title III - Institutional Aid

Title III of the HEA, Institutional Aid was amended by combining the current Part A and Part B into a new Part A - Strengthening Institutions. The authorized funding would be used to improve academic quality, institutional management and financial stability of institutions serving a large percentage of disadvantaged students. Requirements for eligibility would include:

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[68] U.S. Congress. Senate. Committee on Labor and Human Resources. Reauthorization of the Higher Education Act: Program Descriptions, Issues, and Options. Committee Print. 99th Cong., 1st Sess., Washington, U.S. Govt. Print. Off., 1985. 494 p.

[69] U.S. Library of Congress. Congressional Research Service. Higher Education Act: Reauthorization Issues. Issue Brief No. IB84070, by Susan Boren, Nov. 3, 1986 (continually updated). Washington, 1986. 23 p.

[70] Higher Education Daily - Special Supplement. Capitol Publications, Inc. Oct. 1986. Alexandria, VA. 16 p.

(1) Fifty percent of an institution's student body receiving need-based aid under Title IV; and

(2) A significant percentage of students receiving Pell Grants.

Part B of Title III, Strengthening Historically Black Colleges and Universities, authorizes the establishment of grants to improve the quality of historically black colleges. Grants would be provided directly to eligible institutions under a statutory allocation formula determined by the percentage of Pell Grant recipients at each institution, the number of students who graduate within five years, and the number of students who are accepted by graduate and professional schools.[71] The legislation allows that up to 50 percent of the funding could be used for constructing or maintaining a classroom, library, laboratory, or other instructional facility. In addition, this part stipulates that a proportion of the grants would be retained for graduate institutions.

Part C of Title III, Challenge Grants, remains similar to past legislation, authorizing 50-50 matching grants to assist institutions in gaining financial independence. The authorization for part A is $120 million; part B, $105 million (includes $5 million for graduate institutions); and part C, $20 million.

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[71] Eligible institutions include many institutions which are more than 100 years old, at least one established as late as 1963, one created in the 1940s, three whose student enrollments are no longer majority black and several historically black colleges which have (or will be) merged with traditionally white institutions. Higher Education Amendments of 1986. p. 367.

## Title VII - Construction, Reconstruction and Renovation of Academic Facilities

Part A, Grants for Construction, Reconstruction and Renovation of Undergraduate Academic Facilities, Part B, Grants for Construction, Reconstruction and Renovation of Graduate Facilities, and Part C, Loans for Construction, Reconstruction, and Renovation of Academic Facilities are reauthorized at $15 million, $10 million, and $25 million respectively, for FY 1987 and such sums as may be necessary for each of the 4 succeeding fiscal years. The legislation allows that a maximum of 10 percent of the funding in parts A, B, and C be used for instructional or research equipment and for providing a suitable environment (upgrading facilities) for such equipment. The upgrading deemed necessary by an institution must " . . . be essential to the continued utility of the research or instructional instrumentation and equipment."[72] (Part A has not been funded since 1973.)

A new Part D of Title VII, Grants to Pay Interest on Debt authorizes a program of interest grants to assist higher education institutions and building agencies in reducing the cost of borrowing from other non-Federal sources for projects that are partially funded through part C loans. A limitation of $13.5 million is placed on the total amount of annual interest grants which may be paid to institutions and building agencies within a given year.

A new Part E of Title VII of the HEA, College Construction Loan Insurance Association (the Corporation), authorizes the establishment of a joint venture among the Secretary of Education, the Student Loan Marketing Association and interested individuals in the public and academic community. It was authorized $20 million for FY 1987. It is designed to guarantee and insure bonds and loans for the construction and renovation of academic facilities primarily for those institutions that cannot obtain financing in the private market. The current means of financing facilities construction and maintenance are limited to internal funding, borrowing, indirect costs and capital gift campaigns, none being a viable means of financing significant investment in plant and equipment for the majority of universities.[73] It was found that borrowing was used by only a small percentage of higher education institutions and that bank financing options, short-term in nature, were not conducive to construction. In addition, academic institutions' investment in the tax-exempt bond market, while serving as a necessary source of capital for higher education, was limited to "investment grade" as characterized by the bond rating agencies.[74] The need for credit was recognized by those institutions that were "non-investment grade" yet fundamentally sound. The House Committee on Education and Labor proposed a Federal/private partnership (private for-profit corporation) whose purpose would be to " . . . enhance the credit quality of non-investment grade but fundamentally sound educational institutions seeking funds for facility construction, capital improvement, scientific instrumentation and related equipment used for the purposes of higher education and training."[75]

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[72] Higher Education Amendments of 1986, p. 440.

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[73] Higher Education Amendments of 1985, p. 72.

[74] Investment grade refers to academic institutions considered to be of the highest credit calibre.

[75] U.S. Congress. House. Committee on Education and Labor. Higher Education Amendments of 1985. Report to Accompany H.R. 3700. House Report No. 99-383, 99th Cong., 1st Sess. Washington, U.S. Govt. Print. Off., 1985, p. 70.

Part F of Title VII, Housing and Other Educational Facilities Loans reauthorizes loans to assist undergraduate postsecondary educational institutions for constructing, reconstructing, or renovating housing, academic facilities, or other educational and research facilities. One requirement of this part is that the educational institution seeking a loan is unable to secure construction funding from other sources of similar terms and conditions.

Part G of Title VII, Special Programs authorizes the provision of financial assistance for the purpose of construction and renovation to the following institutions: Bethune Cookman College, $6.2 million; Eastern Michigan University (Welch Hall), $2.0 million; Rochester Institute of Technology, $1.8 million; and Shaw University (Estey Hall), $550,000.

## Health Research Extension Act of 1985, P.L. 99-158

The Health Research Extension Act of 1985, P.L. 99-158, Title IV, National Research Institutes, Part G, Section 497, General Provisions, authorizes the receipt and acknowledgement of gifts ($50,000 or more) for acquiring grounds or for erecting, or maintaining facilities for the National Institutes of Health or a national research institute which may exist at universities. Gifts given in accordance with this section may also be used for equipment.

## Food Security Act of 1985 (P.L. 99-198), Title XIV, National Agricultural Research, Extension, and Teaching Policy Act Amendments of 1985

Provisions are contained in the Food Security Act of 1985 (P.L. 99-198) for the U.S. Department of Agriculture to support academic agricultural research facilities for FY 1988 through FY 1990.[76] This Act authorizes funds for research facilities in the amount of $20 million for each of the fiscal years 1986 through 1990. Amendments contained in this section allow the funds provided under the Act to be used also for the acquisition of equipment. This section requires that the research dollars go only to those institutions committed to agriculture and related research. In previous legislation, institutions with an "adequate" research program could compete for funds. The funds are to be used for planning, constructing, and repairing buildings and for buying or leasing land by the Agricultural Research Service. Planning is limited to $500,000 and total cost is limited to $5 million.[77] A requirement is made that reports on construction activity by location be submitted to Congress within 60 days of the end of each fiscal year.

The Food and Security Act gives particular focus to the 1890 land-grant institutions by authorizing program grant awards to upgrade

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[76] U.S. Congress. House. Committee of Conference. Food Security Act of 1985. Conference Report to Accompany H.R. 2100. House Report No. 99-447, 99th Cong., 1st Sess. Washington, U.S. Govt. Print. Off., 1985. p. 203.

[77] U.S. Dept. of Agriculture. Economic Research Service. Provisions of the Food Security Act of 1985. Washington, Apr. 1986. p. 61.

1890 extension facilities.[78] Since 1914, the 1890 land-grant institutions, including Tuskegee Institute, have assisted in the delivery of cooperative extension programs to eligible clients in 16 States. Both the Smith-Lever Act of 1972 and the National Agricultural Research, Extension, and Teaching Policy Act of 1977 provided program funding for facility construction at 1890 land-grant institutions. However, the facilities situation reportedly remains critical at these institutions.[79] Though the needs vary on the campuses, commonalities do exist, with such problems cited as:

(1) limited space in old buildings needing major renovation;

(2) expansion of present staff beyond facility capacity;

(3) need for facilities to expand State programs for such activities as conferences, fairs, livestock shows; and

(4) need for facilities to capitalize on new and emerging technologies.[80]

The Act establishes a new grant program to provide $10 million for each of the fiscal years 1986 through 1990, with such sums to remain available until expended. Approximately 4 percent of the funds would be available for administration of the program, with the balance available to eligible institutions for the purpose of assisting in the purchase of equipment and land, and the planning, construction, alteration, or renovation of buildings, to provide adequate facilities to conduct extension work in a balanced way in meeting the needs of the people of their respective States. The Act stipulates that funds cannot be used for the payment of any overhead costs of the eligible institution.

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[78] The passage of the Second Morrill Act in 1890 required States with dual systems of higher education to provide land-grant institutions for blacks as well as whites. As a result, some new public black institutions were founded, and some private black schools came under public control; eventually 16 black institutions were designated as land grant colleges.

[79] U.S. Congress. House. Committee on Agriculture. Food Security Act of 1985. Report to Accompany H.R. 2100. House Report No. 99-271, 99th Cong., 1st Sess. Washington, U.S. Govt. Print. Off., 1985, p. 119.

[80] Ibid., p. 119-120.

## Tax Reform Act of 1986, P. L. 99-154

On October 22, 1986, President Reagan signed into law the Tax Reform Act of 1986 (P.L. 99-154). Provisions are contained in the legislation that probably will have a significant impact on colleges and universities. Of particular concern is that the legislation imposes a ceiling of $150 million on the amount of tax exempt bonds which any independent institution of higher education could have outstanding at one time.[81] Another major concern is that the repeal of the investment tax credit and the reduced depreciation allowance for companies might weaken the incentive for companies to invest in education. In addition, the act makes charitable gifts of appreciated property liable to the alternate minimum tax. Prior to the passage of the tax legislation, charitable gifts were fully deductible, and were reported to account for 40 percent of private giving to both public and private colleges and universities. In a written statement, Robert M. Rosenzweig, president of the Association of American Universities and Robert H. Atwell, president of the American Council on Education, concluded that:

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[81] A tax exempt bond is a debt obligation issued by a State or local government or subdivision thereof, the interest of which is exempt from Federal income tax. Thomas Head, Association of American Universities. Telephone interview, Oct. 14, 1986.

> . . . [H]owever one views the merits of the [act] in general, it will also seriously impair the ability of educational institutions to raise funds from private sources, exclude twenty or more major research universities from issuing tax-exempt bonds to finance instructional and research facilities, and tax the scholarships of students. The savings to the government from these provisions will be negligible; the damage to education and research will be substantial.[82]

## National Science Foundation Authorization Act for Fiscal Year 1986, P.L. 99-159

The National Science Foundation Authorization Act for Fiscal Year 1986, Title I, Section 108, Data Collection and Analysis, authorizes the National Science Foundation (NSF) to design a data collection and analysis capability for the purpose of identifying and assessing the research facilities needs of colleges and universities. This action was requested because of lack of information in this area. Documentation of the needs of universities, by major field of science and engineering, would include expenditures for the construction and modernization of research laboratories, fixed equipment and major research equipment needs, and sources of funds. The survey, conducted every 2 years, would be the responsibility of the NSF and other appropriate agencies. This section required that the report be submitted to the Congress by September 1, 1986. A summary of the findings from the first survey of facilities needs can be found in chapter six of this report.

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[82] Rosenzweig, Robert M. Association of American Universities and Robert H. Atwell, American Council on Education. Tax Bill Harmful to Colleges and Universities. News Release. Aug. 19, 1986.

## High Technology Morrill Act, S. 935

The High Technology Morrill Act would have established a national technology education grants program for the purpose of providing matching Federal assistance to joint initiatives by private industry, educational institutions, and State governments. The Act specified that grants made under this act may be used for laboratory equipment and facilities in educational institutions and research/education centers for training new scientific, engineering, and technical employees while conducting applied research or stimulating innovation, technology transfer and the application of new technologies. Introduced in April 1985, this legislation was not acted on in the 99th Congress.

## High Technology Research and Scientific Education Act of 1985, S. 58, H.R. 1188

The High Technology Research and Scientific Education Act of 1985, S. 58, amends the Internal Revenue Code of 1954 to make permanent the income tax credit for research and development (R&D). It would have allowed corporations income tax deductions for contributions of scientific and technical property to a higher education institution.[83] The legislation would have modified the charitable contribution deduction of corporations for scientific and technical property to:

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[83] It defined scientific and technical property to mean tangible personal property used in a trade or business, which is donated for the direct education of students or faculty, for research and experimentation or for research training in the United States in mathematics, the physical, biological, or chemical sciences, engineering, or advanced computer sciences.

(1) expand the eligible uses to which the property may be put to include direct education as well as research and research training;

(2) make computer software eligible for the deduction; and

(3) make state-of-the-art equipment used in the taxpayer's trade or business eligible for the deduction.[84]

Introduced in January 1985, no action was taken on the bill after committee referral in the Senate in January 1985 and the House in February 1985.

## Trade Development Investment Act, H.R. 4719

The Trade Development Investment Act, H.R. 4719, set forth provisions to enhance the competitiveness of the United States in international markets by increasing the public investment in education and training. Introduced in April 1986, no action was taken on the bill after its referral to the Subcommittee on Trade in May 1986. Subtitle B, Part 1, Replacement and Modernization of College Research Facilities - University Research Facilities Revitalization Act of 1986, required each of the major Federal research and development agencies to establish and conduct a new university research laboratory modernization program. The legislation defined the major Federal R&D agencies as: (1) the National Science Foundation, (2) the Department of Health and Human Services, (3) the Department of Defense, (4) the Department of Energy, (5) the National Aeronautics and Space Administration; and (6) the Department of Agriculture. Support would have been an amount equal to a specified portion of the funds available to the agency involved for R&D awards to colleges and universities and would have been reserved for the replacement or modernization of such institutions' obsolete laboratories and other research facilities. Funds would have been awarded in response to specific proposals submitted by the institutions and on a competitive basis in an amount not exceeding 50 percent of the cost of the replacement or modernization involved. Authorizations for H.R. 4719 were $465 million, with $100 million directed to the NSF. The legislation would also have transferred $50 million to the NSF under Title 1 of the Education for Economic Security Act, and provide for tax incentives for qualified organizations to support basic research.

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[84] Danforth, John C. Remarks in the Senate. Congressional Record., Daily Edition, v. 131, Jan. 3, 1985. p. S176.

## America's Living Standard Act of 1986, S. 2810

The America's Living Standard Act of 1986, S. 2810, set forth various provisions to promote economic competitiveness in the United States. Of particular importance to higher education was Title V, University Research Fund, which required awards to be made to institutions of higher education for the Federal share of the cost of acquiring, replacing, renovating, upgrading, or constructing facilities and equipment to be principally used for scientific research or laboratory instruction. Restrictions contained in the legislation stipulated that not more than 50 percent of the amount of each award be used for permanently installed experiment equipment and that not more than 25 percent of any such award be used for the purchase of stand-alone equipment. Any college or university receiving an award was required to provide matching funds derived from a non-Federal source. The legislation authorized $250 million to be appropriated for the fiscal year ending September 30, 1987, and each fiscal year there after ending prior to October 1, 1987.

Research Facilities Revitalization Act of 1985, H.R. 2823

On June 20, 1985, the University Research Facilities Revitalization Act of 1985, H.R. 2823, was introduced by Representative Don Fuqua, chairman, House Science and Technology Committee. Provisions within the legislation would have authorized $10 billion over a 10-year period for the replacement or modernization of obsolete university and college laboratories and other research facilities ($5 billion in Federal funds redirected from elsewhere in the Federal R&D budget, and $5 billion in matching non-Federal funds).[85] The funds would have been distributed among the six major Federal research and development (R&D) agencies, the National Science Foundation (NSF), the Department of Health and Human Services (DHHS), the Department of Defense (DOD), the Department of Energy (DOE), the National Aeronautics and Space Administration (NASA), and the Department of Agriculture (USDA). The agencies would have had discretion in implementation of the facility modernization programs, which could include mixed-use structures (facilities used for both research and instruction).

The six agency program would have been within the jurisdiction of four committees, the House Committee on Agriculture, Armed

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[85] U.S. Congress. House. Committee on Science and Technology. Subcommittee on Science, Research and Technology. H.R. 2823 - The University Research Facilities Revitalization Act of 1985. Hearings on H.R. 2823, 99th Cong., 1st Sess., July 30; Oct. 22, 24, 30, 1985. Washington, U.S. Govt. Print. Off., 1986. p. 7. (Hereafter referred to as H.R. 2823--The University Research Facilities Revitalization Act of 1985.)

Services, Energy and Commerce, and the House Committee on Science and Technology. For FY 1987, the first year of the 10-year modernization program, authorizations to the major Federal R&D agencies would have been proportional to each agency's current obligations for R&D to universities and colleges. The total FY 1987 authorization was requested at $470 million: NSF, $100 million, NIH, $200 million, DOD, $100 million, DOE, $25 million, NASA, $20 million, and USDA, $25 million. For the years FY 1988 to FY 1996, the agencies would have been required to set aside approximately 10 percent of their R&D obligations to universities and colleges for their laboratory modernization programs, which would form part of the R&D base of each agency.[86]

H.R. 2823 contained a provision to protect the base of university R&D funding. As structured, the provision prevented the university facility program from growing at a faster pace than the R&D base during years of increased R&D funding. In the event that R&D funding was decreased, the facility program formula would become zero if R&D funding was cut 10 percent or more.

An additional provision in the legislation would have established some protection against favoritism toward the big, well-established research universities over the smaller educational institutions. The legislation provided that at least 15 percent of the amounts that was reserved for the facility programs be available to educational institutions below the first 100 institutions in overall Federal R&D funding.[87]

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[86] Ibid., p. 34.

[87] Ibid.

The NSF would have served as a coordinator by conducting periodic assessments (every two years) of university and college research facility needs and by assessing and reporting the progress in the implementation of the laboratory modernization programs.

The House Science, Research and Technology Subcommittee held a series of hearings in October 1985 on H.R. 2823, but the legislation was not acted on. Testimony was given by individuals in both the public and private sector on the conditions of academic research facilities and the various funding mechanisms proposed for modernizing them. A summary of those hearings follows.

## Overview of the Hearings on the University Research Facilities Revitalization Act of 1985, H.R. 2823

The House Science, Research, and Technology Subcommittee of the House Committee on Science and Technology held three days of hearings in October 1985 on the University Research Facilities Revitalization Act of 1985. Subcommittee Chairman Doug Walgren indicated that the objective of the hearings was to reach a consensus on a Federal program to address the problem of obsolescent and deteriorating facilities.

Opening testimony was provided by Erich Bloch, Director, National Science Foundation. Mr. Bloch acknowledged that modernizing university research facilities was of major importance to the scientific, engineering and technological health of the Nation, but declined to support the bill as it was written. Mr. Bloch argued that the bill, by allocating a fixed proportion of all R&D funds to facilities, would subtract from those funds otherwise available for basic research. Donald Carter, Acting Deputy Undersecretary of

Defense for Research and Advanced Technology, Department of Defense, offered similar reasons for opposing H.R. 2823. He contended that the establishment of a reserve fund for facility construction and renovation would divert resources from both the support of the education of the scientists and engineers and from the total research being performed at different institutions.

Additional witnesses, representing several educational organizations, the American Association of State Colleges and Universities and the American Society of Engineering Education, concurred with the intent of the proposed legislation. These panel members supported the facilities program outlined in H.R. 2823 and maintained that the bill did not divert support away from basic research. However, they did voice concerns about the funding formula contained in the legislation which they felt would restrict agency flexibility to administer programs overlap with existing construction authorities and discriminate against independent research organizations.

Reservations about the requirement for matching funds were expressed by Charles A. Hosler, Jr., Vice President for Research and Graduate Studies, Pennsylvania State University and Member, National Science Board. Due to the present fiscal budget constraints, he suggested reducing the net cost to the Federal Government to as little as 30 percent.[88] He maintained that a 30 percent grant up front from the Federal Government would be adequate to leverage matching sources from private and industrial sectors and from States. During his testimony, Dr. Hosler addressed the issue of indirect costs relative to the support of facilities modernization.[89] He argued that indirect cost reimbursements are in most cases not replacement costs, but are based on the initial cost of equipment and buildings. Hosler cited as an example a building on his campus (Pennsylvania State University), which was erected in 1929 at a cost of $25 million, and has continued to be in active use and is undergoing a $6 million renovation.[90] However, this building is still being assessed, presumably, at a cost of $25 million.[91] He stated: "The fact that you have a lot of very old buildings that have been put to a very long and good use sometimes legislates [sic] against you if you want to recover your costs through the indirect cost mechanism."[92]

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[88] Ibid., p. 212.

Additional comments were made relative to the set-aside provisions of H.R. 2823, indicating that facilities funding should be linked directly with research project awards. John Sherman, Vice President, Association of American Medical Colleges, stated that each agency's university R&D constituents have different construction needs which could be better accommodated through the annual appropriation process. He stated that:

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[89] Indirect costs are those incurred for providing the management, services, and operation and maintenance of facilities required to provide the environment in which research projects are undertaken at academic institutions. One of the seven indirect cost categories is interest payments on borrowed capital to provide research facilities and equipment (for such items acquired after July 1, 1982). Thomas, Eleanor C., Leonard L. Lederman et al. National Science Foundation. Directorate for Scientific, Technological, and International Affairs. Aug. 3, 1984. p. 2. Discussion concerning indirect costs and application for facilities construction can be found further in this chapter.

[90] Ibid., p. 212.

[91] Ibid.

[92] Ibid.

> H.R. 2823's policy of requiring agencies to spend a minimum fixed percentage of their academic R&D budgets for research facility construction is generally undesirable, but it is doubly risky given the absence of comprehensive data on university facilities needs, broken down by discipline and type of institutions."[93] Sherman further recommended that:
>
> (1) The proposed funding formula for university (10 percent for each agency) facilities projects should be dropped and permanent legislative authority or regular authorizations employed instead;
>
> (2) The allocation of 15 percent of HHS'S research facilities program to institutions with smaller research and development budgets should be deleted:
>
> (3) Grant eligibility should be expanded to include "total project costs";
>
> (4) Program eligibility should be extended to university-affiliated hospitals;
>
> (5) Language should be added that allows construction funds to remain available until expended; and
>
> (6) Right-of-recovery language should be added to ensure funds are used for originally intended purposes.[94]

Vijaya L. Melnick, Senior Research Scholar, Center for Applied Research and Urban Policy, University of the District of Columbia; and Charles A. Walker, Dean, School of Pharmacy, Florida A&M University, endorsed the intent of the bill and proposed including support for new construction as well as a focus for historically black colleges and universities. Walker argued that these institutions have always found it difficult to develop their physical infrastructure. He stated that: ". . . for the past decade they [predominantly black institutions] have been provided significant research support from specific institutions and agencies in Washington, but they have never received support for facilities to conduct such research."[95] Walker contended that predominantly black institutions, though having demonstrated their research capabilities, have not participated in science and technology research on a large scale, and would need extra funding in order to get involved.[96] He recommended that 15 percent of the support be allocated for predominantly black institutions and that provisions be made similar to the set-aside of funds recently enacted in the Research Centers in Minority Institutions legislation for the development of research infrastructures at minority institutions.[97] Dr. Walker also stated that most of the predominantly black institutions would find the 50/50 matching requirement difficult to meet, preventing many from becoming involved.

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[93] Ibid., p. 338.

[94] Ibid., p. 342.

### H.R. 1905

On April 1, 1987, Representative Robert A. Roe, chairman of the House Science, Space, and Technology Committee introduced H.R. 1905. The proposed legislation would establish a program in the National Science Foundation for the repair, renovation or replacement of laboratories and other research facilities at universities and colleges. Provision within the legislation would authorize NSF to spend $250 million per-year for the next ten years, with the universities required to obtain matching funds from non-Federal sources.

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[95] Ibid., p. 464.

[96] Ibid.

[97] The Research Centers in Minority Institutions (RCMI) program is designed to expand the national capability for research in the health sciences by assisting, through grant support, predominantly minority institutions that offer the doctorate in the health professions and/or health related sciences. The RCMI is intended to enhance significantly the capacity for the conduct of biomedical and/or behavioral research at such minority institutions by strengthening their research environment.

The legislation also establishes criteria for the awarding of funds to any institution that include:

(1) the quality of the research and training to be carried out in the facility or facilities involved;

(2) the congruence of the institution's research activities with the future research mission of the National Science Foundation; and

(3) the contribution which the project will make toward meeting university research and related training needs.

The legislation also proposes that 15 percent of the total amount appropriated be available only to universities and colleges that receive less than $10 million in total Federal R&D in each of the two preceding fiscal years.

## SELECTED AGENCY POLICY ALTERNATIVES

### Policy Change by the NSF in Support of Research Facilities

After the NSF Authorization Act of 1986, The National Science Board of the NSF issued an "Important Notice" (no. 98) to universities and research organizations amending and clarifying its policy on supporting facilities construction and renovations. The National Science Board maintains that institutions should be able to recover the cost of facilities through indirect cost mechanism based on a reasonable expected life of the facility and realistic rates of recovery. The Board also announced that it would consider facility proposals along with research and instrumentation needs in its funding decisions. Erich Bloch, Director, National Science Foundation stated that:

> It is the Foundation's policy that principal responsibility for providing facilities for research and education remains with academic institutions. The Foundation will, however, consider limited support for facilities when a compelling case can be made.[98]

According to the NSF, however, current fiscal budget constraints will prevent the foundation from making available special funding for facilities. As a result, those proposals submitted that include funds for facilities construction, renovation, or improvement will be considered along with all other proposals received by the NSF. Mr. Bloch stated that in most cases, NSF would establish a policy to give first consideration to project support, next to major equipment and instrumentation, and finally to facilities. However, he noted that exceptions could be made. " . . . [I]n fields in which research is especially dependent on specialized facilities, and a compelling argument is made that facilities are required to achieve specific research or education objectives, facilities support will be provided."[99]

### Proposed Revision of Office of Management and Budget (OMB) Circular A-1, "Cost Principles for Educational Institutions"

There has been extensive debate by Congress, the research community and colleges and universities concerning the problem of rising indirect (overhead) costs of Government-funded academic research projects. Estimates for indirect cost payments in FY 1978 were approximately $900 million, an amount equal to 36 percent of the funds for the direct cost of research and development to colleges and universities.[100] The significant growth in indirect costs was witnessed in FY 1984 when estimated payments for indirect costs to institutions rose to approximately $1.7 billion, 43.6 percent of the estimated $3.9 billion for direct scientific research and development.[101] (See table 5.1.) The most salient increase in indirect costs was for payments for departmental administration, rising from $275 million in FY 1978 to $558 million in FY 1984.[102]

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[98] National Science Foundation. Important Notice to Presidents of Universities and Colleges and Heads of Other National Science Foundation Grantee Organizations. Notice No. 98. Sept. 27, 1985.

[99] Ibid.

The Office of Management and Budget's (OMB) Circular A-21 sets Government wide accounting principles for direct and indirect costs of Federal grants to colleges and universities. While there has been almost no controversy over the reasonableness and necessity of direct costs, there has been considerable controversy over indirect cost reimbursements. The OMB lists seven categories of indirect costs: (1) operation and maintenance expenses; (2) use charges for buildings and equipment; (3) library expenses; (4) sponsored projects administration; (5) general administration; (6) student administration and services; and (7) departmental administration. In summary, indirect costs can be divided into infrastructure and administrative costs. The first three categories are rarely controversial, with the increases being accounted for in three ways: (1) inflation; (2) more universities claiming facilities depreciation rather than the straight 2 percent use allowance, and (3) universities reexamining their accounting procedures and more accurately allocating building and equipment use and fuel costs to the cost of conducting research.[103]

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[100] According to HHS, the direct cost of R&D is the total amount of Federal obligations to universities for R&D minus the total indirect cost payments to universities (e.g., Total R&D FY 1984 = 5.6 billion - $1.7 billion = $3.9 billion as the direct cost of research).

[101] U.S. Dept. of Health and Human Services. Office of the Inspector General. The Impact of Indirect Costs on Research Sponsored by the Federal Government at Universities and Colleges. Memorandum ACN01-61004. Dec. 23, 1985. p. 2.

[102] Ibid., p. 8.

TABLE 5.1. Approximate Amount Paid to Universities
for Indirect Cost Components
by All Federal Agencies
(In Millions of Dollars)

| Cost Components | 1982 | 1983 | 1984 | ---3 Year--- Totals | ---3 Year--- Ratio |
|---|---|---|---|---|---|
| Use Allowances/Depreciation on Buildings and Equipment | $123 | $138 | $163 | $ 424 | 9% |
| Operation and Maintenance of Physical Plant | 351 | 412 | 482 | 1245 | 28% |
| General Administration | 216 | 228 | 264 | 709 | 16% |
| Departmental Administration (Including Deans' Offices) | 415 | 489 | 558 | 1462 | 33% |
| Sponsored Projects Administration | 97 | 103 | 112 | 312 | 7% |
| Library | 62 | 64 | 72 | 198 | 4% |
| Student Services | 18 | 6 | 4 | 28 | 1% |
| Other | 29 | 39 | 51 | 119 | 3% |
| Totals | $1,310 | $1,480 | $1,706 | $4,496 | 100% |

Source: U.S. Congress. House. Committee on Science and Technology. The Federal Government and the University Research Infrastructure. Hearings, 99th Cong., 1st Sess., May 21, 22: Sept. 5, 1985. Written testimony of Henry G. Kirschemann, Jr.

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[103] Ibid., p. 2.

It is the four departmental administrative costs components that are the least definitive and have been controversial and difficult to evaluate in terms of their benefit to federally sponsored research projects. In addition, these administrative cost pools have been difficult to quantify and challenge under the current provisions because of a lack of criteria for specifying the types of allowable costs. The variability is evident in that total departmental administrative rates, as a percentage of total direct costs, have ranged anywhere from 9.0 percent to 24.8 percent.[104]

As a result of the controversy surrounding indirect costs, numerous proposals have been made to restructure the way in which indirect costs are computed and reimbursement policies put into practice. Included in the proposals is one to allow the indirect cost mechanism to address the specific concerns of physical research infrastructure needs.[105] Such a proposal would entail increasing the allowable Federal reimbursements of indirect cost rates, making additional revenue available for upgrading the physical research facilities of colleges and universities.

## HOUSE SCIENCE AND TECHNOLOGY TASK FORCE HEARINGS ON THE UNIVERSITY RESEARCH INFRASTRUCTURE

The House Committee on Science and Technology, Task Force on Science Policy, held hearings on May 21, 22 and September 5, 1985, on the physical condition of research infrastructure in U.S. colleges and universities. In testimony before the committee, Bernadine Healy, Chairman, Research Institute, Cleveland Clinic Foundation and former Deputy Director, Office of Science and Technology Policy, stated that the physical infrastructure of the universities directly affects the productivity of the research enterprise, the quality of talent of the college graduate and the overall ability of the universities to respond to an increasing technological society. She contended that, for more than a decade, the partnerships among industry, Government and the university have not addressed the issue of infrastructure. Because of the deficiencies in the physical infrastructure of the institutions, questions have been raised as to whether the colleges and universities will be able to train the very best talent consistently and continuously in order to ensure adequate future levels of scientific productivity.[106]

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[104] Ibid.

[105] Thomas, Eleanor C., Leonard L. Lederman et al. National Science Foundation. Directorate for Scientific, Technological, and International Affairs. Indirect Costs of Federally Funded Academic Research. Aug. 1984. p. 16 (unpublished paper).

Use allowance as an indirect cost component received considerable debate.[107] Dr. Healy suggested making the cost recovery basis significantly shorter for depreciation for buildings and also for instruments. The present use allowance is two percent for buildings which assumes a 50-year life and a six and two thirds percent for equipment which assumes a 16 or 17 year life.[108] She maintained that the actual average useful life for buildings is probably about 20-25 years, the same as used for industrial laboratories.[109] The amortization period for equipment is also unrealistically long, she said, and should be six to eight years.[110] She proposed that a framework be constructed in which institutions are reimbursed realistically for facilities and equipment used in federally sponsored research. She also said that colleges and universities should assume leadership in identifying cost savings associated with research overhead.[111]

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[106] The Federal Government and the University Research Infrastructure, p. 4.

[107] Use allowance or depreciation is compensation for the use of an institution's buildings and equipment, provided they are needed and used for institutional activities and are properly allocable to sponsored agreements. The Impact of Indirect Costs on Research Sponsored by the Federal Government at Universities and Colleges. p. 4. (Memorandum ACN01-61004. Dec. 23, 1985. HHS Office of the Inspector General)

[108] The Federal Government and the University Research Structure, p. 53.

In discussion on the use allowance, Representative George Brown noted that the efficient rebuilding of the physical infrastructure required long-range planning and proposed changes in the use allowance to help address the longer term capital needs of academia. He suggested increasing the use allowance to 15 or 20 percent, thus permitting institutions to use the increased use allowance to make mortgage payments on new facilities and equipment.

During the hearings, Henry G. Kirschenmann, Jr., Deputy Assistant Secretary, Procurement, Assistance and Logistics, Department of Health and Human Services responded to questions on the amounts of indirect costs paid to institutions as part of the total costs of research grants and contracts, as well as the extent to which these payments support the research infrastructure of the institutions. Concern was expressed as to the disproportionate growth in indirect costs in comparison with direct costs to colleges and universities.

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[109] Ibid., p. 5.

[110] Ibid.

[111] Ibid.

Data indicate that total Federal obligations to colleges and universities increased from $1.9 billion in FY 1972 to more than $5 billion in FY 1983, approximately a 160 percent increase.[112] During that same period, total estimated indirect cost payments to colleges and universities increased 275 percent, from $400 million to $1.5 billion.[113] Table 5.1 gives a more recent comparison of indirect cost components negotiated by the Department of Health and Human Services. The figures indicate that for FY 1982, FY 1983, and FY 1984, the administrative costs alone totalled 55.8 percent of the indirect cost rate. While this growth of indirect costs also reflects an increase in Federal contribution to physical facilities, only 37 percent of those costs go to all forms of suppport for facilities (table 5.1--9 percent for fixed costs, and 28 percent for operations and maintenance). The issue of Federal involvement in infrastructure needs, however, was not discussed by Mr. Kirschenmann.

An industry perspective regarding the research infrastructure at colleges and universities was offered by Frank B. Sprow, Vice President, Exxon Research Engineering Co., Annandale, N.J. Sprow was in agreement that a new Federal approach is needed for funding university research facilities requirements on a continuous basis. Sprow also encouraged the adoption of supplemental institutional grants to universities for establishing centralized research facilities. These centralized research facilities would be collaboratively managed by the institutions using them and would facilitate the acquisition, maintenance, and sharing of instrumentation. Sprow did note, however, that some collaborations presently exist between industry and universities. Sprow stated that:

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[112] Ibid., p. 24.

[113] Ibid.

> At some cost threshold, it is clear that centralized research facilities are necessary, because the infrastructure required to support research is simply too expensive to continue to exist under the purview of the individual researcher, a single department, a single university, or a single company.[114]

## CONCLUSIONS

Though estimates vary as to the cost of renovating and modernizing university research infrastructure, the scientific research community is in agreement that deficiencies clearly exist, threatening the vitality of the Nation's academic scientific enterprise. As university research activities grow in scope, there is evidence that the deficiencies in the present infrastructure of the university system may become more pronounced. Some contend that the Federal Government should increase its commitment to university research infrastructure, while others feel that private industry and the States should be more directly involved. Legislation was proposed during the 99th Congress in an effort to alleviate the problems of the research infrastructure. Program and policy alternatives were also given by members of the scientific research community for the purpose of improving the present conditions of the university system.

Many in the academic community support the intent of both Mr. Fuqua's and Mr. Roe's proposed legislation because the bills recognize the long term nature of the facilities problem; provide upfront capital many universities do not have access to; require matching funds from non-Federal sources; set aside funds for universities with smaller R&D programs; and require peer review for all institutions proposing facilities projects. While not all agree that a greater Federal role is needed, there is general agreement among interested observers, including the administration, that a growing problem exists.

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[114] Ibid., p. 186.

# CHAPTER VI. REVIEW OF RECENT SURVEYS OF ACADEMIC RESEARCH FACILITIES NEEDS

## INTRODUCTION

Besides the efforts of the Federal Government, various higher education organizations and associations, as well as individual analysts have issued major reports and held numerous meetings regarding the current state of university research facilities. This chapter reviews a number of different surveys aimed at evaluating the overall condition of university research facilities. The focus of this chapter is on surveys conducted since 1980, by different educational organizations, as well as the Federal Government.

## RECENT SURVEYS ON UNIVERSITY RESEARCH FACILITIES ACTIVITIES

Despite the deepening concerns of the Nation's academic community about the state of university research facilities, Congress has been reluctant to act, in part, because of a lack of quantitative data detailing the extent and areas of need for upgrading and renovating such facilities. In an attempt to obtain a better information base on current university research facilities construction and renovation activities, Congress requested the National Science Foundation (NSF) to conduct an assessment of academic research facilities needs. Congress directed NSF:

> . . . to design, establish, and maintain a data collection and analysis capability in the Foundation for the purpose of identifying and assessing the research facilities needs of universities . . . . The Foundation, in conjunction with other appropriate Federal agencies, shall conduct the necessary survey every 2 years and report the results to Congress.[115]

Because of time constraints, the first report, which was due to Congress in less than a year, focused on doctorate-granting universities only. NSF surveyed 165 doctoral granting institutions (108 public and 57 private) and conducted over 400 interviews with 80 research administrators and 175 deans representing 318 programs in eight scientific fields and engineering. The scientific fields included: medical, life, computer, social, mathematical, physical, environmental, and psychological.

The universities that participated in the survey accounted for 83 percent of all Federally funded research and development (R&D) expenditures at universities and medical schools in 1984. The public universities conducted 53 percent of the total with the private schools accounting for the remaining 30 percent.[116]

To help Congress evaluate facility needs, the report provides information on the amount of space devoted to research at doctorate-granting institutions, expenditures on facilities related activities in progress and planned, as well as the age of the facilities. The report also summarizes research administrators' and deans' perceptions of facilities' needs based on 400 interviews.[117]

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[115] National Science Foundation Authorization Act for Fiscal Year 1986. P.L. 99-159, Section 108.

[116] Ibid., p. 2.

[117] Science and Engineering Research Facilities At Doctorate-Granting Institutions. National Science Foundation, Sept. 1986. p. 1. (Hereafter referred to as the NSF Doctoral Granting Survey.)

Besides the recent NSF survey, there have been several other limited studies that have tried to evaluate academic facilities needs. In 1981, the Association of American Universities (AAU) conducted a mail survey of 15 universities (7 private and 8 public) to try and answer the following questions.

1. How much have the Nation's leading universities spent, from all sources, over the last four years (through 1981) to construct and refurbish research facilities, including major research equipment?
2. What do universities estimate their facilities and major equipment needs will be over the next three years to permit current faculty to continue quality research and education programs?
3. In the judgment of department heads and faculty, what will be the consequences for science, industry, and government if the accumulated facilities and equipment needs of the Nation's leading universities are not addressed?[118]

According to AAU, the 15 universities in their study, accounted for 22 percent of total Federal R&D spending in FY 1979.[119]

Two other university research facility studies were released in 1984 by the National Science Foundation. The first, conducted by an Ad Hoc Interagency Steering Committee on Academic Research Facilities and coordinated by NSF, examined past and future facility needs of 25 universities.[120] The second study surveyed 248 of NSF's principal investigators (PIs) and university research administrators from five

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[118] The Nation's Deteriorating University Research Facilities. Association of American Universities, July 1981. p. 2. (Hereafter referred to as, The AAU Study.)

[119] Ibid., p. 2.

[120] Adequacy of Academic Research Facilities. A brief report of A Survey of Recent Expenditures and Projected Needs in Twenty-Five Academic Institutions. Ad Hoc Interagency Steering Committee on Academic Research Facilities. NSF Task Group on Academic Research Facilities, Apr. 1984. (Hereafter referred to as the Interagency Survey.)

NSF divisions: Physics, Chemistry, Earth Science, Electrical, Computer, and Systems Engineering, and Physiological, Cellular, and Molecular Biology. The PIs and research administrators were questioned regarding their perceptions of both instrumentation and facility needs.

One of the weaknesses of NSF's PI survey is that it does not indicate the number and type of universities (public or private) surveyed. However, it does indicate that 21 percent of the PIs were from the top 24 schools which had received the largest amount of Federal R&D funding. While 75 percent of the PIs were from the top 100 universities receiving Federal R&D funding, with only 25 percent from universities that fell below the top 100 largest recipients.[121]

Finally it is important to note that both the AAU study and NSF's PI survey present data on both instrumentation and facilities as a single cost. As was indicated earlier in the report, because many universities had difficulty in separating out large instrumentation and facility costs (the AAU study includes only instrumentation that costs over $100,000) they often report them as a single physical plant expenditure. This is why NSF's doctoral granting survey is so important, because it focuses on university research facilities only.

## Survey Findings

The following sections of the chapter review the major findings of the different university research facilities surveys that were reviewed for this report. A list of the surveys that were reviewed can be found in appendix A.

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[121] University Research Facilities: Report on a Survey Among National Science Foundation Grantees. National Science Foundation, June 1, 1984. p. 3. (Hereafter referred to as NSF's PI Survey.)

## Federal Funding for Research Facilities Construction

Although the different surveys do not focus exclusively on university research facilities, they all come to the same conclusion regarding direct Federal support for the university infrastructure. Beginning in the late 1960s and early 1970s the share of Federal funding for facilities construction decreased dramatically and will likely continue to do so in the future. Federal funding for facilities accounted for 25 to 30 percent of the total between 1965 and 1970, and has dropped to a current level below 10 percent. According to NSF, this trend is expected to continue in the next five years, with Federal support accounting for only 6 percent of the total in 1991.[122]

These findings were reinforced by a recent Government Accounting Office (GAO) report that examined current Federal funding mechanisms for university research. According to the 10 public and 8 private institutions surveyed, their Federal share of physical plant support had decreased from 13 percent of the total in 1975 down to 4 percent in 1984.[123]

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[122] NSF Doctoral Granting Survey, p. xiv.

[123] Report to the chairman, Committee on Science and Technology, House of Representatives. University Finances Research Revenues and Expenditures, GAO, July 1986. p. 40. (Hereafter referred to as the GAO Study.)

## Current and Future Institutional Spending Plans

A second major finding is that the majority of the universities surveyed are utilizing a number of different approaches to meet their current and future research facilities needs.

For example, NSF's doctoral granting survey showed that 62 percent of the universities surveyed were engaged in new construction, with 77 percent reporting upgrading or making major repairs on existing facilities.[124] (See figure 6.1) A majority of the research administrators and deans at the top 50 schools (54 percent see page 17 for definition), rated research facilities on their campus as good or excellent.[125] While the majority of those officials at schools below the top 50 (55 percent) reported the condition of their research facilities as fair or poor. (See figure 6-3.) The estimated completion cost of all facilities work in progress for the 1985-86 academic year was $1.7 billion.[126]

According to NSF's PI survey, 73 percent of the research facilities had experienced some renovation in the last ten years, at a median cost of $400,000.[127] While AAU's 1981 survey revealed that between 1977-1981, the 15 universities it surveyed had spent $400 million for new construction, modernization, major repair and renovation of their research facilities and special purpose research equipment.[128]

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[124] According to NSF upgrading and renovation are costs associated with enhancing the R&D capability of a facility, complying with Government regulations, or gutting and rebuilding an existing facility. Major repairs includes costs associated with repairing deteriorated conditions, such as a new roof. NSF Doctoral Granting Survey. p. B-5.

[125] According to NSF the "Top 50" are the top 50 universities ranked in terms of research and development expenditures in 1984.

[126] Ibid., p. 7.

[127] NSF PI Survey, p. 5.

NSF's doctoral granting survey provides additional information about current facilities renovation activities. The survey noted that a much larger percentage of public schools (72 percent compared to 44 percent) than private schools, were engaged in new construction activities. Further, as figure 6.2 indicates, private universities were more likely than public schools to be upgrading and renovating research facilities, but the latter were spending slightly more.[129]

The top 50 schools were spending more than twice as much for both upgrading and renovation and major repairs, compared to those universities below the top 50. For example, in the area of upgrading and renovation, the top 50 averaged $5.3 million compared to $1.8 million for the remaining schools, and for major repairs $1.6 million compared to $700,000 for those institutions below the top 50.[130]

Regarding future activities, over 80 percent of the universities are planning to construct new research facilities, according to NSF's doctoral granting survey. The completion cost over this five-year period is expected to be $5.8 billion. Administrators contacted in NSF's PI survey estimated that 47 percent of their buildings were slated for renovation at a median cost of $425,000.[131] AAU's survey results indicated that the 15 universities responding will need to spend approximately $460 million for new construction in the next three years.[132]

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[128] AAU study, p. 7.

[129] NSF Doctoral Granting Survey, p. 12.

[130] Ibid.

[131] NSF PI Survey, p. 5.

NSF's interagency survey of 25 universities estimated that about $495 million per year of construction, remodeling, and refurbishment of science, engineering, and medical research facilities is planned over the next five years. According to the NSF report if "these plans were scaled up in proportion to the share of Federally funded R&D, [received by these universities] all universities and colleges would require over the next five years about $1.3 billion per year for these purposes."[133] This estimate would result in a five-year total expenditure of $6.5 billion, close to the $5.8 billion that the NSF doctoral granting study indicated.

Further analysis of NSF's doctoral granting findings reveals that the top 50 schools plan to spend about three times as much as the other institutions for constructing new research facilities. Public universities were more likely than private universities to have new construction planned (figure 6.2) but the private schools planned to spend more.[134] (Private schools averaged $35 million, compared to $31 million for the public institutions.)

Approximately 84 percent of the universities planned to upgrade or renovate existing research and development facilities, with the top 50 schools estimating expenditures substantially higher than the others. In the next five years three-fourths of the universities plan major repairs, with the top 50 institutions projected to spend amounts two and one-half times greater than the other universities, $9 million compared to $3.4 million.[135]

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[132] AAU study, p. 9.

[133] NSF Interagency study. Initial Report. Apr. 1984.

[134] NSF Doctoral Granting Survey, p. 13.

## Factors Affecting Facilities Construction Activities

The NSF's doctoral granting survey found was that a majority of research administrators and deans did not believe the: "inability to obtain loans, restriction on the use of endowments and grants, legal restrictions, lack of campus space, and pressure to develop teaching rather than research capabilities, constrained their university from addressing its facility needs."[136] However, 48 percent of the research administrators said restrictions on grants and endowments were a problem while 38 percent said lack of space hurt their ability to address facility needs. A greater proportion of the deans felt the lack of campus space hindered their efforts to address facilities needs.[137] Only 14 percent of the research administrators felt that their inability to obtain loans hurt their ability to address their research facility requirements.

## Facilities Funding Is a Marginal Expense

One of the most interesting findings that emerged from the NSF doctoral granting survey was that both the research administrators and deans viewed facilities funding as a "marginal expense" relative to personnel and equipment.[138] Fifty-six percent of the research administrators said new additional funds would be spent on facilities first. However, the administrators indicated that facilities expenditures would be cut first if funding were reduced, followed by equipment and then personnel. The deans were less likely to use additional research funds for facilities, although they were somewhat less likely to make reductions here first.[139]

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[135] Ibid., p. 14.

[136] Ibid., p. 25.

[137] Ibid., p. 28.

NSF's PI survey asked both administrators and PIs to rank six items in relation to the importance they should receive in the spending of university funds, with the primary goal of improving research. Four of the six items referred to human resource needs. The PIs and research administrators chose instrumentation as the most important research need. Research facilities was considered the second highest need, followed by personnel needs.[140]

## Sources of Funding for Facilities Construction

Funding for university research activities are derived from four major sources, the Federal Government, State governments, tax-exempt bonds, and private donations or endowments. As might be expected, all the surveys indicated that public and private institutions rely on very different sources of funding for facilities activities. According to the NSF doctoral granting survey, the public institutions depend on State resources for most of their facility funding. The private institutions depend on a broader mix of funding sources including the Federal Government. (See figure 6.4.) For example, for construction now in progress, public universities receive 53 percent of their funds from the State and 35 percent from tax-exempt bonds. Concomitantly, the Federal Government and private donations account for 35 percent and 29 percent respectively of private university research facility construction.[141] These funding patterns also hold for upgrading and major repairs with one exception. Private universities obtained 29 percent of their funds for upgrading existing facilities through tax-exempt bonds.

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[138] Ibid., p. 21.

[139] Ibid., p. 25.

[140] NSF PI Survey, p. 15.

GAO's University Finances study also showed that universities receive funding for research facilities from a variety of sources. In 1984, the 10 public and 8 private universities in GAO's survey received 55 percent of their funds for facilities from institutional sources (money from the university's general fund, unrestricted money usually given to the university by other sources) 29 percent from State sources, 12 percent from private gifts and 4 percent (down from 13 percent in 1974) from the Federal Government.[142] The GAO study also revealed that public universities received 45 percent of their funds in 1975 and 1984 from State sources, while private universities received nothing from these sources.[143]

For future work (1986-1991) all of the universities in NSF's doctoral granting survey expect less direct Federal money for new construction. Private sources, and to a lesser extent, State Governments, are expected to compensate for the decrease in Federal support. Over 60 percent of the costs will be provided by State sources at public schools, with donations and endowments accounting for 40 percent of the funds at private universities. As figure 6-4 demonstrates, when compared to work in progress, private universities will generally rely more on tax-exempt bonds to finance planned work, with the public universities relying less on that source.[144]

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[141] NSF Doctoral Granting Survey, p. 15.

[142] GAO Study, p. 40.

[143] Ibid., p. 41.

These data do not include Federal tax expenditures (resulting from taxes foregone from charitable contributions and tax-exempt bonds) nor indirect costs on research grants. Congressional line-item appropriations for specific facilities may be included but that is not certain. Indirect costs, to date, have not gone for new construction (table 5.1), and line-item appropriations to date ($145 million) are less than four percent of new construction costs for work planned in 1986-91 (about $4.03 billion according to the NSF survey).

## Availability of Current Research Space

Both research administrators and deans agreed that the lack of research space was a more serious problem than the general condition of research facilities. Three-quarters of the research administrators felt that research space was a more critical need than upgrading or repairing existing space. The deans interviewed said that research space affected their ability to get and keep high quality researchers and that the space problem greatly contributed to what a majority of them felt was their most pressing problem for the next five years, personnel. One-third of the interviewed deans, however, felt that inadequate facilities was the biggest problem they faced about research.[145] In addition, over 60 percent said they had less research space than they needed and a majority said additional space was a more critical problem than upgrading existing research space.

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[144] NSF Doctoral Granting Survey, p. 18.

The major difference between research administrators and deans was in their overall rating of current research space. While the research administrators tended to rate university research facilities as good or fair, the deans tended to rate current facilities as poor.

Interestingly enough, the PIs in NSF's 1984 survey also mentioned the problem of space more frequently in their comments than any other potential problem. Over 38 percent of the PIs categorized current research facilities as crowded. This was true for all fields except engineering. Further, PI's working in new buildings were more likely to feel crowded than those working in buildings more than 10 years old (50 percent versus 38 percent).[146]

## Age of Research Facilities

Earlier surveys including AAU's and NSF's PI survey seem to indicate that the condition of university research facilities roughly corresponded to their age. However, results of NSF's doctoral granting survey seem to indicate that age "was only a gross, and sometime misleading, measure of condition."[147] NSF reported that 43 percent of academic research facilities were constructed or renovated between 1970 and 1986.[148]

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[145] Ibid., p. 25.

[146] NSF's PI Survey, p. 11.

[147] NSF Doctoral Granting Survey, p. 18.

[148] Ibid.

Since the top 50 schools tend to be older than the other schools they, on average, had somewhat older facilities. According to officials of the top 50 schools, 65 percent of their facilities were built or renovated prior to 1970, with 29 percent of facilities work occurring in the 1960s. Only 54 percent of those schools below the top 50 reported new construction or renovation activities prior to 1970.[149]

## Assessment of Academic Research Facilities by Field of Science

Results of NSF's doctoral granting survey indicate that academic officials believe that the most pressing need for facilities is in engineering, and medical, life and physical sciences. Current and planned construction is concentrated in these four areas. On a campus-wide basis, research administrators believe facility needs are greatest in biological, biomedical and physical sciences, engineering, and biotechnology.[150]

These findings are consistent with AAU's evaluation by field of science. In 1981 AAU estimated that for the next three years construction would be concentrated in the fields of engineering, medical sciences, biological sciences, and chemical sciences.[151] The results of NSF's doctoral granting survey reinforces AAU's construction projections, especially in the areas of engineering and medical sciences.

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[149] Ibid., p. 19.

[150] Ibid., p. 33.

[151] AAU Study, p. 10c.

According to NSF's doctoral granting survey, deans representing physical and environmental sciences were more likely than others to consider facilities their greatest problem. This is probably due to the fact that in these two areas, along with social sciences, research facilities are relatively old compared to facilities in other research areas.[152]

The only area in which deans rated facilities good or excellent was in the medical sciences. Deans representing engineering and social sciences indicated that they had less research space than they needed. However, this may change soon because at least two-thirds of the 130 universities with engineering schools were currently building facilities in this area or planning to do so.[153]

In the areas of psychology and physical and life sciences, deans reported that current facilities limited the number of projects that could be done. However, deans from medical sciences and engineering departments reported most often that facilities needs limited the type of projects and diverted funds from other uses. The most pressing areas in engineering include materials, biochemical and biotechnical engineering, and microelectronics, and electrical engineering. Lack of campus space was a major problem with one dean remarking that:

> In analyzing the facilities needs, one should take into account that NSF and other agencies are now sponsoring large interdisciplinary research projects such as the engineering research centers. These kind of programs will require substantial additional space in the institutions where they are established. Furthermore, engineering education has changed dramatically in the last twenty-five years, from concentration on undergraduate teaching to a mix of undergraduate and graduate teaching and research. Many

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[152] NSF's Doctoral Granting Survey, p. 33.

[153] Ibid., p. 36.

> institutions have serious facilities shortages and faculty problems as a result of these changes.[154]

However, as noted above, space limitations may soon improve in engineering since two-thirds of the 130 universities with engineering programs were currently building facilities or planning to do so.

In the field of physical sciences, 80 percent of the deans said they had less research space than they needed. The areas of greatest need are in physics and chemistry. One dean said he needed, "a place to house a telescope NSF gave us money for ten years ago."[155] Over 85 percent of the deans in physical sciences said facilities limited the number and type of research projects that can be carried out.[156]

According to the deans, conditions in environmental sciences were worse than any other area. The fields most often mentioned are geology, atmospheric science, and meteorology. Eighty percent of the deans said that conditions of facilities limited various activities that could be carried out.[157] Mathematical science were less of a problem than any other field, according to the deans. They indicated that attracting and keeping mathematicians are the most serious concerns. This is primarily due to a lack of adequate office space.[158]

More than any other area, facilities in computer science were more likely to be ranked excellent by their deans. In this area, deans ranked personnel issues, attracting faculty and graduate students, as their most serious problem in the next five years.[159]

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[154] Ibid., p. 37-38.

[155] Ibid., p. 39.

[156] Ibid.

[157] Ibid., p. 41.

[158] Ibid., p. 43.

Approximately half the deans surveyed indicated that life science facilities were in better condition than any other area except medical sciences. In general, medical science facilities tend to be relatively new. One-half of the newest facilities in the 111 universities with medical science programs have been constructed since 1979.[160]

Over 80 percent of the deans in life sciences said that facilities needs limited the number and type of experiments that could be conducted. Temperature control was the major facilities-related problem in this area. One dean commented that

> The biology building is not air conditioned . . . In the summertime, in a hot spell, the temperature will get up into the nineties, which is not good for either the people or the processing equipment. The fields with the most pressing needs are biochemistry, biophysics, microbiology and plant biology.[161]

Again, lack of campus space was the most frequently mentioned problem addressing medical sciences facilities needs. Forty-four percent of the deans said additional research money would be spent on facilities first. However, almost 70 percent of the deans reported that facilities funding would be cut first if research budgets declined. In medical sciences the areas of greatest need for research facilities are neurobiology, molecular biology, and molecular genetics.[162]

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[159] Ibid., p. 45.

[160] Ibid., p. 49.

[161] Ibid., p. 47.

[162] Ibid., p. 49.

Of all the fields of science, the deans representing psychology gave their facilities the overall lowest rating. About 24 percent of them characterized them as poor, another 26 percent rated them only as fair, with 37 percent and 3 percent rating them as good or excellent respectively.[163] Further, only 16 percent of the 148 institutions with psychology programs plan to build facilities in the 1985-86 academic year. Also, only 50 percent of the deans indicated that additional space is their most serious facilities need. Nevertheless, several deans mentioned crowding and dispersion of faculty as a problem. For example, one dean said "faculty morale and interest is low and the ability to recruit graduate students constrained because the work in psychology is split in different buildings that are inadequate to meet the needs of faculty."[164]

Finally, the social sciences contain the oldest research facilities, with half of the buildings constructed prior to 1940 and the other half built before 1972. As with psychology, the deans rated social science facilities lower than other science fields. Only 38 percent of the deans said facilities were better than fair, while 15 percent said they were poor. However, compared to deans in other areas deans representing social sciences gave facilities the lowest priority ranking for the next five years. More of the deans (44 percent) considered personnel issues, recruiting graduate students and faculty, more important.[165]

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[163] Ibid., p. A-8.

[164] Ibid., p. 51.

[165] Ibid., p. 53.

## UNIVERSITY REACTION TO NSF'S DOCTORAL GRANTING SURVEY

Although the university community supports congressional attempts to determine the current condition and level of need for research facilities, people speaking for the academic community, in general, are not happy with how NSF chose to interpret its survey findings.[166] Most university officials do not question the validity of the data collected, but rather believe that NSF tended to accentuate the positive aspects of the data, while underplaying the data's negative implications. They believe that this optimistic and perhaps inaccurate interpretation of some of the data may compromise efforts to secure new Federal funds in research facilities construction.

For example, NSF reported that 54 percent of research administrators from the top 50 schools rated their research facilities as good or excellent, while 45 percent of the remaining administrators placed their facilities in these categories.[167] University representatives point out that this means 46 percent and 55 percent of the research administrators from the top 50 institutions and those below the top 50 schools, rated their research facilities as fair or poor. They point out that this means that nearly half of the Nation's universities are conducting research in facilities that are rated fair to poor.

Interestingly enough, NSF data indicate that only 4 percent of the respondents rated their research facilities as excellent, while another 4 percent indicated they were in poor condition. Consequently, 89 percent of the research administrators said their facilities were in good (44 percent) or fair (45 percent) condition. (Four percent did not know the condition of their facilities.)[168]

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[166] The information obtained in this section was primarily obtained, by the Congressional Research Service, through personal discussions with academic officials from different universities and higher educational associations, such as AAU.

[167] Ibid., p. 29.

Regarding the present condition of research facilities and their impact on conducting certain types of research, NSF reported,

> Most research administrators said that facilities needs constrained their research efforts. Nonetheless, research administrators at top 50 schools were less likely than those at schools ranked below the top 50 to say that facilities limited the types of research projects carried out and diverted funds from other uses to maintain facilities.[169]

University officials point out that in fact NSF's own data indicates that 88 percent of the research administrators from the top 50 schools said research facilities limit the number and type of projects they could support and that 75 percent had diverted funds from other uses to support their facilities.[170] Again, academic representatives contend NSF's wording tends to underplay the extent to which all the universities surveyed are forced to compromise the type and amounts of research the current condition of their facilities allow them to conduct.

University representatives contend that the current design of NSF's survey is incapable of accurately reflecting the extent of the overall need for research facilities at colleges and universities as requested by Congress. Recently, Linda S. Wilson, Vice President for Research, at the University of Michigan wrote that,

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[168] Ibid., p. A-15.

[169] Ibid., p. 30.

[170] Ibid., p. A-19.

> past expenditure levels and current plans for the future are inadequate as measures of the need for future expenditures. Institutional plans are heavily guided by pragmatic assessments of the amount of capital funds expected from public and private sources. Recently, such plans have grossly underestimated actual need.[171]

Academic officials suggest NSF must first develop a definition of need, determine how to measure it and the extent to which universities have been successful in meeting their facility needs.

For example, to help determine how successful universities have been in meeting their needs, some university critics have suggested that NSF should ask questions about the number of research facilities approved for construction, that have been cancelled or delayed due to lack of funding. Further, they suggest that NSF should also try and determine the extent to which current or planned facilities activities had to be modified because of insufficient capital.

NSF did not ask any questions about plant debt. Many university finance experts are concerned that some universities may be increasing their plant debt due, in part, to borrowing for research facilities. Information on the growth of plant debt is important because it can help to determine how well certain universities are able to meet current and future research facility needs. A recent GAO study indicated that between 1975 and 1984 private university plant debt had increased 88 percent.[172] (Only 9 private universities were surveyed by GAO.)

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[171] Wilson, Linda S. The Capital Facilities Dilemma. In The State of Graduate Education, E. Bruce, L. R. Smith. Brookings Institution, Washington, D.C. 1985. p. 134.

[172] Briefing Report to the chairman, Committee on Science and Technology, House of Representative. University Finances Research Revenues and Expenditures. General Accounting Office, July 1986. p. 43.

Another concern of university financial officers is NSF's treatment of tax exempt bonds as a coequal source of funds with Federal and State funds, and private donations and endowments. In reality, they contend, tax exempt bonds are a source of cash or debt, that the university is obligated to pay off through a variety of sources, including building and equipment use from indirect cost allowances. The tax exemption, however, reduces the cost of borrowing and is a subsidy.

Those responding to the NSF survey objected to NSF's characterization of facilities expenditures as a "marginal expense." They argue that it should come as no surprise to the Foundation that universities would choose to cut facilities activities first and their research personnel last, if funding were reduced. The majority of universities would protect their research personnel first, since they represent the most important asset of any research program. NSF has responded that the term "margin expense" was used purely in an economic sense and it was not intended to imply that research facilities are not a serious university concern.

Some academic officials also believe that the NSF survey should have attempted to gather data on the consequences for universities that are funding large facilities projects. Often these projects result in universities deferring crucial maintenance on existing facilities, under-investing in undergraduate and graduate education, and reducing student aid. These are just some of the responsibilities of universities that have to compete with facilities funding.

Finally, in general, people speaking for the academic community believe that many of these problems could have been avoided if it had been more involved in helping NSF develop its original survey instrument. Academics have asked NSF for more input into any revisions they make in the questionnaire, in preparation for the Foundation's 1988 research facilities report to Congress.

In response to these criticisms, NSF contends the report is not written to foreclose any options, that its staff did the best it could under the existing time constraints and that it could not substantiate all of the academic claims in support of Federal funding. NSF does not agree with all the criticisms, but has indicated that questions about plant debt will be included in the next survey. Further, NSF has already requested that the academic community help in revising its facility questionnaire for the 1988 congressional report.

## CONCLUSION

In general, both the NSF doctoral granting and PI surveys do not seem to indicate a national crisis in university research facilities. However, all the surveys, including NSF's doctoral granting survey, show that in general, the Nation's universities are confronted with a research facilities problem that some regard as serious. The survey results suggest that, in the absence of an active direct Federal involvement in research facilities funding, the universities surveyed have embarked on a very aggressive mix of investment strategies in order to respond to their various research facilities needs. Further, the survey results indicate that a large percentage of both private and public universities have been involved in or are planning new research facilities construction activities in the next three to five years. Most direct Federal support goes to help facilities construction in private schools.

However, this does not necessarily mean that some type of Federal research facility program is not needed to help the Nation's universities meet their future research facility needs. For example, results of NSF's doctoral granting survey, suggest that in certain fields of science (e.g., physical and environmental sciences) more resources are needed to alleviate current facilities problems. If the States, which support most facilities construction at public colleges, for one reason or another, are not able to maintain their current level of research facilities funding, therefore, where would the needed capital resources come from? Further it is not clear how the new tax law will affect future sources of funds that the private universities rely on to finance planned research facilities activities. Consequently, Congress may wish to explore what options the Federal Government might have in helping universities improve their ability to meet current and future research facilities needs.

# CHAPTER VII. FINANCING UNIVERSITY R&D FACILITIES

## INTRODUCTION

There is much construction of new research facilities at the Nation's universities underway and planned, and a multi-source system of funding these new facilities has been created. Despite these accomplishments, several studies show a growing, unmet need to replace obsolete university research facilities since the late 1960s. Further, the different reports contend (see especially the report of the White House Science Council, Academic Research Facilities: Financing Strategies, and Crumbling Academe) that in more recent years this unmet need was accelerated by the high inflation of the late 1970s, rapidly changing requirements of research facilities, and, as chapter four indicated, a drop in Federal funding of university facilities construction. According to Erich Bloch, director of the National Science Foundation, "Federal outlays for R&D plant, as a percentage of total federal R&D, have declined from nearly seven percent in 1965 to less than one percent in 1983 and are still falling."[173]

The ability to finance the accumulated research facilities capital deficit is now of significant concern to many of the country's colleges and universities, especially when many of the top research universities are located in States that have experienced serious economic problems. Further the universities have a number of other responsibilities, that require major financial resources including, improving undergraduate and graduate education, maintaining existing buildings, improving faculty and staff compensation, financing student aid and purchasing new research equipment.

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[173] Peer Review and Special Interest Facilities Funding, A paper for the National Academy of Science Roundtable, Nov. 19, 1984. p. 7.

Some contend the different estimates of the magnitude of the research facilities problem itself constraint action and inhibits the willingness of the Federal Government and others to respond. According to NSF, one-half of the university's physical plants (research laboratories, equipment, libraries and classrooms) are over 25 years old, and one-quarter were constructed before World War II.[174] Various analysts and reports estimate the total need for replacing and upgrading current university research facilities at anywhere from $30 to $40 billion.[175] A number of university officials have stated that during an era of fiscal stringency, it always has been far more expedient to defer capital expenditures on "brick and mortar until tomorrow."[176]

This chapter reviews a number of proposals that have been developed by different analysts, individuals in the academic community and various representatives of higher education associations to assist the universities in obtaining funds for financing the construction and renovation of university research facilities.

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[174] An Action Agenda for American Competitiveness. Business-Higher Education Forum, Sept. 1986. p. 15. (Hereafter referred to as An Agenda for Action.)

[175] Ibid., p. 16.

[176] Ibid.

## SUMMARY OF DIFFERENT FINANCING PROPOSALS

In July of 1985 over 200 university administrators, researchers, Government officials and representatives of scientific and professional societies met to examine and discuss different strategies universities might implement to finance their growing research facilities construction needs.[177] The goal of the financing conference was not to adopt a consensus recommendation. Rather, the conference participants were asked to develop a comprehensive set of recommendations aimed at meeting university research facilities funding needs on both a short- and long-term basis. The participants were also asked to keep in mind the diverse needs of both public and private universities. As a result the participants developed a set of major action items.

However, before discussing these items it is important to review some conclusions the conference participants reached regarding the funding of research facilities. First, the participants concluded, not surprisingly, that despite its small size, Federal Government support for research facilities is an essential part of the Government's basic research funding program and second, that there are two ways of approaching Federal funding for facilities. First there is payment up front by a Federal facilities grant or second, there is payment over time via indirect costs.[178]

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[177] Academic Research Facilities: Financing Strategies. Report of a Conference July 22-23, 1985, National Science Board, National Academy Press, Washington, D.C. 1986. (Hereafter referred to as Financing Strategies Conference.)

[178] Ibid., p. 32.

Further, these two approaches differ in three different ways. First, payment over time limits access to only those universities that can provide or secure the initial capital required to build the research facility, capital that will be reimbursed in part or in whole through indirect cost recovery. Facilities grants help to eliminate the problem of access to large amounts of capital.

Second, there is a difference in the type of peer review that occurs under these two approaches. Payment over time uses existing peer review methods, while separate facilities grants require a more aggregate evaluation and review of an institution's programs.[179] These types of peer review panels were in operation in the 1950s and 1960s, but are currently not active because there were no Federal research facilities grant programs in operation until 1987. Direct congressional appropriations for facilities is an upfront payment approach which so far has not been accompanied by peer review. Finally, the third dimension is who takes the risk. For payment over time the institution takes the risk. For facilities grants the Federal Government takes the risk in proportion to its share of the overall funding.[180] When reviewing the following ten recommendations, it is important to keep these differentiations in mind.

The following recommendations (1-10) were made by the academic community and can be found on pages 3 through 14, in the Academic Research Facilities: Financing Strategies, report. None of these recommendations originated from the Congressional Research Service.

1. The use allowance for facilities under OMB Circular A-21 should be increased from the present two percent to five percent.

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[179] Ibid., p. 33.

[180] Ibid.

As chapter five indicated one of the components of indirect costs (IC) chargeable to the Federal Government in R&D grants and contracts with universities is use allowance for research buildings. Currently, the standard allowance is 2 percent a year. Under the use allowance category, universities are permitted, with the approval of the Department of Health and Human Services or the Defense Department, to apply a specific documented depreciation rate for their buildings. Further, beginning in 1982, universities were also allowed to claim interest on certain loans used for the construction or renovation of research facilities.[181]

A number of different reports, including those by the White House Science Council and the Business-Higher Education Forum contend the real average useful life of a university research facility is approximately 20 years, rather than the current assumption of 50 years.[182] Participants at the financing strategy meeting felt that decreasing the use allowance to a 20 year period would: 1) link support for particular facilities with individual research projects that, in most cases, have passed the test of peer review; and 2) would allow for a faster rate of recovery of institutional funds used to maintain facilities and to repay loans used for construction or renovation.

Testifying before Congress, Henry G. Kirschenmann, Jr. Deputy Assistant Secretary for Procurement, Assistance and Logistics,

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[181] Ibid., p. 3.

[182] Report of the White House Science Council. Panel on the Health of U.S. Colleges and Universities, Feb. 1986. p. 15. (Hereafter referred to as the White House Council Report.) Also see Toward A Competitiveness Agenda. Highlights of the 1985 Winter Meeting of the Business-Higher Education Forum, Jan. 24-26, 1985. p. 24. ( Hereafter referred to as the Competitiveness Agenda Report.)

Department of Health and Human Services, (HHS) pointed out that between 1982 and 1984 use allowance and depreciation on buildings and equipment accounted for only ten percent of total indirect costs paid to colleges and universities. (See chapter five for a further discussion of how the different indirect costs components are allocated to university research.) Mr. Kirschenmann testified that out of a total of $424 million paid for use allowance between 1982 and 1984, 43 percent, or $183 million, was for buildings and 57 percent, or $241 million was for research equipment.[183]

If use allowance were increased from 2 to 5 percent per year, HHS estimates an additional cost of approximately (keeping in mind university indirect costs keep moving upward) of $155 to $165 million per year for building use only.[184]

The General Accounting Office (GAO) in its 1986 study of University Finances, Research Revenues and Expenditure, examined indirect costs for building depreciation compared with capital expenditures. GAO surveyed 15 public and 9 private universities and found that "between 1980 and 1984, the annual university investment for construction in science and engineering was 9 to 12 times higher than the annual Federal indirect cost reimbursement for building depreciation, in current dollars."[185]

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[183] Statement of Henry G. Kirschenmann Jr., before the Task Force on Science Policy Committee on Science and Technology. U.S. House of Representatives, May 21, 1985.

[184] Information provided by an HHS official.

[185] Briefing Report to the chairman, Committee on Science and Technology, House of Representative. University Finances Research Revenues and Expenditures. General Accounting Office, July 1986. p. 43. (Hereafter referred to as the GAO Research Revenue Study.)

The average cost for capital expenditures at each university GAO surveyed grew from $4 million to $7 million during this time period. This growth in spending was due entirely to the private universities, which began the period averaging $3 million and ended up at $12 million in 1984. In current dollars, annual Federal reimbursement for building use allowance at each university increased from $400,000 in 1980, to $600,000 in 1984. Again, the private universities accounted for the increase, jumping from an average of $600,000 to $1 million in 1984. The public universities averaged $300,000 per school in annual use allowance reimbursements.[186]

Participants at the financing strategy conference noted the primary disadvantage to increasing use allowance is that it fails to provide access to the initial capital often needed by universities to start construction on a new research facility. Others noted that increasing the cost of use allowance could reduce the availability of overall research support unless Federal funds for research were increased.

Finally, Robert Sproull, President Emeritus, University of Rochester, recommended to the participants that charges for rent of research space be made an explicit component of Federal R&D indirect cost component. (See appendix B for further details.) Sproull's basic approach is to assemble the costs that appropriately would be counted as part of rent of research space and deal separately with the "basket" as rent-per-square foot of space used on federally supported project. He claims that rent is easily understandable and readily comparable, and therefore less controversy could be anticipated in this part of the pooled costs.[187] According to Sproull, the elements of the rent calculation would include: 1) building depreciation and obsolescence; 2) routine maintenance; 3) security; 4) grounds care; 5) parking lot costs for space required by people associated with the building space; and 6) heat, power, light, "pure waters" charges.[188]

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[186] Ibid., p. 43.

The proposal recognizes that although rent would be part of indirect costs, some components of indirect costs would require changes. For example, "central administration" would probably stay the same, but "research grants and contracts administration," now 100 percent in the pool, would be put in at some lesser percentage, perhaps 85 or 90 percent.[189]

2. An independent nonprofit corporation should be established to finance academic research facilities.

The attendees of the facilities financing strategy conference pointed out that only 300 of the Nation's 3,000 institutions of higher education have effective access to the existing tax-exempt bond market. The remaining universities lack credibility with private lenders, who are not used to evaluating the risks of lending money to academic institutions. The participants contend that most of these universities are financially healthy but they need a mechanism to provide guarantees of their financial performance to private lenders.[190]

The GAO study of research revenues and expenditures, help to shed some light on this problem by examining the ratio of physical plant debt to current university fund expenditures. GAO found that in constant 1984 dollars, current fund expenditures grew much faster than plant debt between 1975 and 1984. During this time period, debt grew 13 percent, while current fund expenditures rose 35 percent.[191]

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[187] Financing Strategies Conference, p. 132.

[188] Ibid.

[189] Ibid.

[190] Ibid., p. 4.

However, there were significant differences between the 15 public and 9 private institutions GAO surveyed. Physical debt for the 9 private universities increased 86 percent, while public university debt decreased by 16 percent. Further, private plant debt in proportion to overall private expenditures rose from 25 percent in 1975 to 34 percent in 1984. Concomitantly, public university plant debt declined from 32 percent of expenditures to 21 percent.[192]

One approach suggested to provide universities initial access to large amounts of capital was the creation of an independent, nonprofit corporation to provide low-rate loans, loan guarantees, and other financial assistance for research and educational facilities. (See appendix C for further details of this proposal.) It was suggested that the corporation should be established with a one-time Federal appropriation of $500 million, with funds added from private sources. The corporation would issue its own bonds, using the initial capital as backing, and use the capital obtained to make loans to colleges and universities for construction and renovation. Income from the capital could be used to offset administrative costs and to subsidize interest costs for the facilities loans.[193]

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[191] GAO Research Revenue Study, p. 47.

[192] Ibid.

[193] Ibid., p. 5.

It was also suggested that the corporation could establish a merit-review system with respect to access to loan funds. Having made the loans it then would sell the securities in the secondary markets, very much like the Federal National Mortgage Association or the Student Loan Marketing Association. Consequently, it would improve the risk characteristic of the debt, while increasing access to private capital and making the whole process more efficient.[194]

The conference participants reported that the provision of funds prior to construction or renovation was a major advantage for the university. By issuing its own bonds and lending the proceeds to qualifying institutions, the corporation would diversify risk, while hopefully providing lower interest rates to borrowers. Most importantly, the corporation would provide access to tax-free bonds to many institutions that would otherwise not have such access. Finally, it was pointed out that the peer review process for such facilities should involve a review of the universities' business plans, as well as a review of scientific merits.[195]

A similar idea was embodied in legislation that was recently passed by Congress when it reauthorized Title VII of the Higher Education Act of 1965, and established a Facility Loan Guarantee Corporation. (See chapter 5 for further details P.L. 99-498.) Among other provisions contained in Title VII, is the establishment of the College Construction Loan Insurance Association (CCLIA). It will be organized through the Department of Education and Treasury and the Student Loan Marketing Association (SLMA). The CCLIA will issue stock and use the proceeds to guarantee and insure bonds, loans, leases, and other debt instruments for any "educational facilities purpose."[196] These funds would be available primarily to "non-investment grade"[197] universities for such facilities activities as construction, renovation or the purchase of research equipment. The Association will be funded at $50 million in FY 1987.

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[194] Ibid., p. 36.

[195] Ibid., p. 5.

The university community essentially endorses this new Association. Most research administrators have pointed out that the SLMA has done a good job in support of student aid. Since it was established in 1972, it has attracted private capital in excess of $650 million, and supports some $14 billion in loans to college students.[198] Consequently, the SLMA has gained considerable credibility in the commercial market place.

3. The concept embodied in H.R. 2823, a bill to authorize increased Federal support for construction and renovation of academia research facilities, should be supported. Funds should not be provided on a set-aside basis, however, but should supplement existing research funds.

Members of the Business-Higher Education Forum stated that a lack of a clear legislative authority to address the research facilities problem has prevented many Federal R&D agencies from initiating any large-scale facilities construction or renovation program. Further, the Forum pointed out that many agencies now lack administrative mechanisms necessary to carry out such a program.[199] As discussed in chapter five, H.R. 2823 would authorize the six major R&D agencies that account for approximately 85 percent of Federal funds (NSF, DOD, DOE, HHS, USDA, and NASA) to establish programs for modernizing college and university laboratories.

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[196] Ibid., p. 5-6.

[197] Investment grade refers to academic institutions considered to be of the highest credit calibre.

[198] Ibid., p. 6.

[199] Financing Strategies Conference, p. 6.

The legislation would authorize funds of $470 million in FY 1987. In the succeeding years to 1996, the six agencies would be required to spend at least 10 percent of their academic R&D funding for further construction activities. Further the various Federal agencies would fund only half of the cost of the proposed construction activity, with the remaining funds coming from institutional or other non-Federal sources.

Those attending the financing strategies meeting generally supported the intent of the legislation and felt that it would be an effective means of leveraging additional funds from the States, industry, and academic institutions.[200] Many of the participants said that the matching requirement was a strong feature, but wanted to be sure that the institutions would have flexibility in the ways such a requirement could be fulfilled.[201]

The major concern, raised at the meeting, regarding the proposed legislation, was the 10 percent set-aside. As might be expected the fear associated with this provision is that there would be 10 percent reduction in funds that would have otherwise supported research.

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[200] Leveraging usually refers to the practice of adding borrowed funds to funds on hand, in order to "leverage" the funds on hand by enabling the institutions to finance bigger projects. Leveraging is inherent, though not always apparent, in virtually every capital project financing in the tax-exempt market. When an institution uses agency financing for a project, it is in essence using the borrowing to leverage its own endowment and cash flow.

[201] Financing Strategies Conference, p. 7.

However, some of the conference participants felt that such a trade-off may be necessary, given the current Federal deficit problems.

Different facility reports have suggested similar programs or endorsed slightly different versions of H.R. 2823. For example, the 1981 AAU study made two recommendations designed to fund university research facility needs. First, AAU recommended that NSF's facilities and equipment initiative of $100 million proposed for FY 1982 be restored. Because of budgetary constraints the Reagan administration withdrew this proposal, which would have provided $75 million for rehabilitation of research laboratories and $25 million for upgrading instructional equipment at schools of engineering.

The second proposal was to establish in each of the mission agencies a facilities rehabilitation program targeted on the fields of science and engineering of primary significance to their mission.[202] The following agencies, DOD, HHS, DOE, NASA, and USDA, would support research facilities development in key areas of research for that particular agency. For example, DOD is a primary supporter of engineering and computer research at universities. Consequently, AAU proposes that DOD should then address the primary laboratory needs at universities that carry out such research for DOD. Finally AAU recommended that the Office of Science and Technology Policy (OSTP) and NSF coordinate such a program.[203]

In its Agenda for American Competitiveness report, the Business-Higher Education Forum presented two proposals for upgrading and maintaining university research facilities. First, it proposed a long-term facilities-modernization program (10 years) to be funded by the six major Federal R&D agencies by allocating, perhaps 5 percent of their annual budgets for financing capital expenditures. Although this might result in fewer research funds, Robert M. Rosenzweig, president of AAU contended, "Most university presidents would accept sacrificing R&D money in order to improve the infrastructure."[204] The participants felt this approach would reestablish the connection between each agency's responsibility for funding both research and the facilities necessary to conduct state-of-the-art research. The participants recommended a decentralized approach rather than having one agency such as NSF coordinate the program.

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[202] AAU Study, p. 22.

[203] Ibid., p. 23.

Secondly, the Forum suggested making a capital budget for R&D equipment and facilities part of the Federal Government's overall R&D mission. As part of its annual analysis of capital investment in the public infrastructure, roads, bridges, and sewers, the review would include expenditures for higher education research infrastructure including: buildings, laboratories, scientific instruments, and libraries. The review would be updated annually and be published as part of Special Analysis D of the Budget of the United States Government.[205]

Finally, the Report of the White House Science Council endorsed H.R. 2823 with two significant modifications. First, it recommended that the facilities program suggested in H.R. 2823 should be located in NSF rather than spread across six major agencies, in order to minimize duplication of effort and for the purpose of establishing uniform standards and procedures.[206] Further, the report recommended that funding for the program should not be taken out of existing R&D budgets but must be provided incrementally to the present R&D budget. Such funds should be included in NSF's budget for the next ten years and awarded on a 50/50 matching basis with non-Federal funding, subject to peer review within the scientific or technical community involved.[207]

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[204] Competitiveness Agenda Report, p. 18.

[205] Ibid., p. 19.

Other than hearings, held by the House Science, and Technology Committee, Congress has taken no action on H.R. 2823 and according to the chairman of a key House subcommittee there may be little future prospect for action. He stated:

> In spite of the massive influence (of the major research universities in my State) the people out there just don't like what you're all about. That may be brutal news to you. Again, we're out there every two years shaking hands and rubbing elbows and doing polling and asking people what they want . . . I think it's due in large part to the people in the public sector (who feed) the anti-intellectualism of the American people. But unless people out there can sense a tangible benefit . . . they think that all that money is going to pointy-headed people to create luxury laboratories for very little benefit for me, and that's a waste of my tax dollar. . . .[208]

If this statement is accurate, (and some Members of Congress and the university community do not think it is) a new general program of Federal facilities aid is unlikely and other means will be sought, among them direct congressional appropriations for specific facilities. Pressure may grow to directly request funds from Congress, to help with the construction of certain university research facilities. This issue--which involves the bypassing peer review--will be discussed in chapter 8 of this report.

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[206] White House Science Panel, p. 14.

[207] Ibid., p. 15.

[208] An Agenda for Action, p. 21.

4. Proposals for tax reform should be monitored to evaluate their effects on facilities funding.

The recent tax reform bill passed by Congress and signed by the President has aroused some concern in the academic community. "The bill is the greatest catastrophe for higher education in 25 years," said Sheldon Steinbach, counsel for the American Council on Education, which represents 1,500 colleges and universities. As a matter of public policy it might seem like a good idea, but as a matter of social policy it's just terrible."[209] Essentially the new tax law contains three provisions that university officials believe, among other things, could seriously impair the Nation's universities' ability to raise money to repair and expand facilities.

The first provision places a cap on the use of tax-exempt bonds by private universities. Under the new law, an individual private university could issue no more than $150 million in tax-exempt bonds at any one time. According to AAU, 24 private universities, including Harvard, Yale, Stanford, and the University of Pennsylvania, already exceed the $150 million in outstanding bonds. Many university officials believe this aspect of the tax law discriminates against the private universities. Some analysts have pointed out that finding ways around the law may be difficult. Nevertheless, some affected schools may try to enter into agreements with institutions that have not reached their caps or work with state universities which are not affected by the cap.[210]

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[209] Tax Bill Provisions Criticized as Harmful to Higher Education. Congressional Record, Sept. 10, 1986. p. S. 12279.

[210] Webre, Philip. Tax Reform: Why All the Whining? The Scientist, Oct. 20, 1986. p. 13.

A participant at the facilities financing strategies conference indicated that if tax-exempt bonds were lost, the cost of capital to universities would increase two to three points. This would feed back through the indirect cost route as a interest cost to universities. Further, maturities for taxable debt are much shorter than those available in the municipal bond market. In fact maturities would come down from 30 years, which is what they are now for academic institutions, to perhaps 10 to 12 years. This will have a very significant effect on the institution's ability to finance research facilities over time.[211]

A recently released survey by NSF of 165 Doctoral Granting Universities revealed that during the 1985-86 academic year 13 percent of the funds used for new construction of research facilities at private universities came from tax-exempt bonds. However, when asked about future new construction (1986-1991), private universities said they plan to obtain 32 percent of their total funding through tax-exempt bonds.[212] Many university officials believe the new tax law provision could prevent a number of universities from implementing some of their building plans, while giving public institutions an unfair advantage.[213] Further, university representatives contend the cap does not reflect either an institution's need to borrow funds or the scope of an institution's educational activities advanced through tax-exempt bonds.

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[211] Financing Strategies Conference, p. 36.

[212] Science and Engineering Research Facilities At Doctorate-Granting Institutions. National Science Foundation, Sept. 1986. p. 17.

[213] Congressional Record, Sept. 10, 1986. p. S. 12280.

A second major provision would make donors of large gifts of appreciated property subject to a minimum tax rate of 21 percent on the increase in value of the donation, making this type of donation less advantageous to the donor. Prior to the new law, the full market value of such gifts, usually real estate and stocks, could be deducted from the donor's gross income. Forty percent (by value) of the gifts to universities worth over $5,000 are gifts of appreciated property. In order to avoid this tax, some donors may chose to spread their gift over several years, which could cause universities some problems.[214] Recent economic studies on sensitivity of charitable giving to its price suggest that charitable giving decreases between 1.2 and 1.3 percent for every 1 percent increase in its price.[215] Private giving represents only one-tenth of university income, and is declining in overall importance.

Although university officials admit private giving may be declining, it is a very important source of funds for construction activities. For example NSF's Doctoral Granting Survey indicated that in academic year 1985-86, private sources of giving accounted for 29 percent of new construction funding. For new construction planned between 1986 and 1991 private giving is expected to account for almost 50 percent of all funds.[216]

Finally, the new tax law eliminates deductions for charitable contributions unless taxpayers itemize their returns. University officials believe that this will discourage recent graduates from making donations, thus making more difficult the early recruiting of important future sources of private giving. Again, such private sources of giving are an important resource for private university research facilities construction activities.

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[214] Tax Reform: Why All the Whining?, p. 13.

[215] Wilson, p. 141.

[216] NSF Doctoral Granting Survey, p. 17.

5. The tax credit now available for research equipment donations should be extended to similar donations for academic research facilities. Generally, thought should be given to new tax inducements for facilities supported by the private sector.

The Economic Recovery Tax Act (ERTA) of 1981 allows research equipment manufacturers that donate equipment to universities to take a tax deduction amounting to half the difference between production cost and the fair market value. The act excludes donation of educational equipment as distinguished from research equipment. Most participants at the financing strategies meeting agreed that donations should be extended to facilities because the distinction that is made between research equipment and facilities is strictly artificial.

Those at the meeting talked about establishing condominium laboratories jointly funded, with portions allocated to the university and the company it is working with. Such an approach would be a step beyond the "incubator" facilities now existing at a number of locations.[217]

There is a provision in the new tax law that allows a 20 percent tax credit for corporations which make donations or enter into agreements with universities and non-profit organizations. It is not clear if a company could claim a tax credit if part of an agreement with a university involved upgrading existing research facilities in order to carry out their joint research venture. The university community believes that it will require assistance from the private sector in order to improve their current research facilities.

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[217] Financing Strategies Conference, p. 40.

> 6. A careful study emphasizing the collection of better data on the state of academic research facilities should be undertaken.

As mentioned in the introduction there is a great deal of variance in the actual estimates regarding the magnitude of the university research facilities problem. The conferees felt these differences were due to definitional problems, sampling techniques, and time periods used. The 1981 AAU study recommended that the OSTP along with the six major Federal research agencies (NSF, DOD, DOE, HHS, NASA, and USDA) should assess the seriousness of the present and future academic research facilities inadequacies.[218]

The lack of accurate data on the current condition of research facilities led Congress to request the National Science Foundation to conduct an assessment of current academic research facilities needs. The survey (which was completed in October of 1986 was discussed in the last chapter) will be conducted every two years and will focus on such things as sources of funding for facilities construction, amount of construction in progress, amount planned in the next five years, and conditions of facilities by field of science.

> 7. State governments should develop comprehensive plans for academic research facilities on the basis of their views of the State's economic future, industrial profile, and labor force needs.

The participants of the financing strategies meeting recognized that State governments have played a key role in helping their universities improve their research infrastructure by forging partnerships with Federal, State and private concerns. Although the resulting investments are not confined to facilities, they do demonstrate the increasing degree to which State governments understand and are willing to deal with facility modernization issues. Finally, States now generally recognize the importance of their university research activities to the economic well being of the different States.[219]

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[218] AAU Study, p. 22.

8. In developing their plans, States should consider a wide range of sources and techniques for funding academic research facilities.

The conference participants recommended a number of funding approaches available to States to finance facilities construction. They include general funding, leveraging of private funds, bonding and other debt financing, lease-purchasing arrangements, dedication of tuition payments to facilities, user fees and rents, and methods of managing indirect costs recovery funds. Further earmarking taxes could provide a steady revenue source to continually construct, maintain, and renovate facilities.[220]

9. Institutions should improve their facility design, construction, and space management practices to reduce cost, to incorporate the best current practices, and to achieve better use of existing and potential facilities.

Those attending the conference recognized that universities need to do a better job of managing and allocating their existing research space. Because the organization of university research is so decentralized, it does not "lend itself to orderly business practices in institutional planning, budgeting, and facility development."[221]

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[219] Financing Strategies Conference, p. 10.

[220] Ibid., p. 12.

[221] Ibid., p. 13.

In his book Crumbling Academe, Harvey Kaiser discusses the idea of a facilities audit, an approach universities may wish to consider. According to Kaiser the facilities audit is the starting point for selecting capital renewal and replacement priorities. It examines the conditions of buildings, grounds and utilities plus their functional appropriateness. The audit evaluates the physical condition and functional adequacy of campus facilities, produces a record of building's characteristics and use, existing condition, an overall facilities rating, and comments on maintenance requirements and repair and renovation needs. The audit is broken down into three phases: designing the audit, collecting the data, and presenting the findings which includes setting priorities for facilities replacement.[222] (See appendix D for further details.)

10. Institutions should reinvestigate their funding sources and alternatives to assure themselves that available opportunities have been tapped to the fullest.

Here the universities were advised, by the conference participants, to undertake a systematic and comprehensive examination of all their alternatives for research facility funding, with a view to expanding their "portfolio" of techniques, resources, and information sources.[223] Conference participants were also urged to look at an AAU report entitled Financing and Managing University Research Equipment, for further suggestions along these lines. Many of the AAU's following recommendations could be applied to facilities management as well. For example, it recommended that:

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[222] Kaiser, Harvey H. Crumbling Academe, Solving the Capital Renewal and Replacement Dilemma. Association of Governing Boards of Universities and Colleges, 1984. p. 17-29.

[223] Ibid., p. 14.

1. That universities more systematically plan their allocation of resources to favor research and equipment in areas that offer the best opportunities to achieve distinction;

2. That universities budget more realistically for the costs of operating and maintaining research equipment;

3. That universities consider establishing inventory systems that facilitate sharing; and

4. That universities act to minimize delays and other problems resulting from procurement procedures associated with the acquisition of research equipment.[224]

## CONCLUSION

Clearly representatives from the academic community recognize that no single source or mechanism of funding will be adequate to meet current research facilities projected needs. As this chapter indicates different funding strategies, involving Federal, State, industry, and universities support and financing are now in use and new ones will continue to be required, if the Nation's universities are to successfully finance their current and future research facilities needs. Further, analysts examining the research facility funding issue have pointed out that the capital deficit problem is a chronic problem not susceptible to a quick fix. Rather, in their view, any approach that is adopted would best be spread across many years as the research facilities needs of the various scientific and engineering disciplines continue to change.

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[224] Financing and Managing University Research Equipment. Association of American Universities, et al. Summary and Recommendations, Washington, D.C., 1985. p. 9.

# CHAPTER VIII. BYPASSING THE PEER REVIEW PROCESS

## INTRODUCTION

In an attempt to build research facilities a growing number of educational institutions have obtained funding for research facilities by appealing directly to Congress and bypassing the peer review process. In FY 1982, such actions amounted to $3 million; however in FY 1987 congressionally earmarked funds for academic research facilities exceeded $145 million.[225]

Commonly referred to as academic "pork barrel," many in the academic community contend that these activities are symptomatic of the overall decline in Federal support for the building of university research facilities. According to some observers, the trend also may reflect the increased political sophistication and activity of states, cities, and academic institutions. While the Federal Government was reducing its direct support (see table 4.1) for facilities, science and engineering research was becoming more expensive and capital intensive. Another significant factor that may be contributing to this phenomena is that some members of Congress believe that universities in their district, in partnership with industry and

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[225] This figure includes $69.7 million for the Department of Energy, $19.9 for the Department of Education and $55.6 for the Department of Defense. These figures are not definitive since there may be additional earmarked funds that have yet to be identified in the various FY 1987 authorization and appropriation bills.

Government, have the potential to contribute to local and regional economic development. Further, it is believed by many university officials and some Members of Congress that such partnerships will not occur without suitable facilities for conducting modern research.

## IS THERE A NEED FOR FACILITIES PEER REVIEW?

According to Robert M. Rosenzweig, president of the Association of American Universities (AAU)[226] the issue "involves a number of instances in which the Congress has made appropriations for the construction of research facilities at particular universities without either a competitive application process or a professional review prior to approval."[227] Dr. Rosenzweig continued by stating that up to now, Congress usually has not been involved in decisions about scientific projects to such an extent. Such decisions "have been made almost entirely without direct congressional involvement, and almost always only after competent professional review of the merits of the work to be done."[228]

A number of educational organizations, the Office of Science and Technology Policy, and the National Science Board of the National Science Foundation have issued statements strongly supporting peer review for funding the construction of university research facilities. For example, in October of 1983, the AAU adopted a statement affirming

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[226] AAU represents 56 member universities, most of them major recipients of Federal research and development funding usually under the peer review process. The AAU has become the voice of academic big science.

[227] Testimony before the House Science and Technology Committee, Task Force on Science Policy, June 26, 1986. p. 6.

[228] Ibid., p. 9.

"the practice of awarding funds for the support of science on the basis of scientific merit, judged in an objective and informed manner," and urging all (primarily the academic community) "to refrain from actions that would make scientific decisions a test of political influence rather than a judge on the quality of work to be done."

Those who oppose this method of funding research facilities contend that this procedure undermines the long established scientific peer review process, which, some say, has been the mechanism for maintaining the excellence of American science. For instance the National Science Board contends that diverting scarce research dollars to projects of "questionable" scientific merit could "threaten the integrity of the U.S. scientific enterprise that is the basis of the scientific, technical, and economic competitive position of the United States in the world."[229] The NSB study also pointed out that circumventing the peer review process for some facilities could begin to undermine the peer review system of Federal support for research at colleges and universities.

To some degree this may already have occurred. Representatives from the Department of Energy (DOE) and the Department of Defense (DOD) have reported that direct FY 1987 appropriations of $69.7 million and $55.6 million respectively, will be supported primarily by funds that were originally designated for research. Administration and academic officials contend this represents cuts in DOE and DOD supported research projects that had been reviewed and approved through a competitive peer review process. While a majority of Congressmen endorse direct funding of some research facilities projects, as evidenced by the legislation enacted, some members object. For instance, Representative Robert Walker stated that congressional approval of facilities without peer review by scientists reinforces the belief that "political determinations are made about science rather than good academic scientific decisions."[230] Clearly, these views do not go uncontested.

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[229] Report of the NSB Committee On Excellence In Science and Engineering. The National Science Board, Feb. 22, 1985. p. 2.

## DO ACTUAL MECHANISMS FOR FACILITIES PEER REVIEW CURRENTLY EXIST?

A number of educational officials believe that direct congressional appropriations does not circumvent peer review. They contend there currently is no formal, well developed or commonly used peer review procedure for funding new university research facilities. This was echoed by M. Richard Rose, President of the Rochester Institute of Technology when he stated, "the criticism that has been leveled at Congress and at universities seeking direct Federal support is based on the false hypothesis that such action circumvents some accepted procedure, when in fact such a procedure does not exist."[231] The Senate DOD Appropriations Committee earmarked, for FY 1987, $11.1 million to help establish the Center for Microelectronics Engineering at Rochester. According to President Rose, "while it is standard practice with respect to research grants, peer review has virtually no part in the allocation of funds for facilities."[232]

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[230] House Endorses Pork Barrel Funding. Science, v. 233, Aug. 8, 1986. p. 617.

[231] Pork-Barrel Science vs. Peer Review. The Chronicle of Higher Education, Oct. 8, 1986. p. 96.

[232] Ibid.

Testifying before the Task Force on Science Policy, John Silber, President of Boston University, defended direct congressional appropriations for research facilities. In FY 1984 Boston University received $19 million in Federal funds to assist in the development of a new $90 million Science and Engineering Center. Dr Silber testified that bypassing peer review for facilities does not undermine the peer review process. Since Federal funds to build research facilities, for the most part, were never subject to "the traditional peer review that applied to proposals from individual investigators."[233]

According to Dr. Silber, "the evidence clearly shows that the real pork barrel in scientific research is the system that benefits the very research universities that have been loudest in claiming the purity of peer review."[234] The idea of peer review Dr. Silber said is commendable if it is applied in part to broaden the institutional and geographic base of science research in the United States. In practice many critics say, the pattern of research awards made using the peer review system is seriously flawed because many smaller schools never qualify for research awards. For example, Dr. Silber pointed out that in

> FY 1983 20 institutions, in three geographic regions of the country (Northeast, Midwest, and West, primarily California) received 40 percent of the total awarded to all 592 research universities receiving Federal research and development (R&D) funding.

Further, in "FY 1983, the top 10 institutions receiving support from

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[233] Prepared statement of Dr. John R. Silber, Science in the Political Process. Task Force on Science Policy, Committee on Science and Technology, 99th Cong., 1st Sess., June 25-26, 1985. p. 68.

[234] Ibid., p. 72.

NSF received 30 percent of all NSF funds and the top 20 institutions received 46 percent of all NSF funds."[235]

President Silber argued that these top universities are actually members of an academic cartel attempting to preserve the current peer review system because "it confers so many benefits upon them."[236] Consequently, the top universities have strongly opposed direct appropriations, because if this practice becomes widespread it could reduce their level of Federal R&D funding.

Finally, Dr. Silber estimated that of the $50.9 billion spent on R&D by the Federal Government in FY 1985, only about $4 billion, or about $.08 of every Federal R&D dollar was actually awarded through a peer review process. He stated that almost all of the research support that is awarded through peer review comes to university faculty members (primarily through NSF and NIH) and is carried on in laboratories and other facilities located on university campuses.[237]

Gerald Cassidy, President of Cassidy and Associates, lobbyist for a number of universities, contends that the current peer review system perpetuates the "old boy network." The network flourishes, he contends, because top funded universities possess a group of distinguished investigators that serve on various peer review panels which render project funding decisions that often affect their colleagues in other established universities. These are colleagues they may have gone to school with, know through professional meetings, or have served with on other peer review panels.[238]

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[235] Ibid.

[236] Ibid., p. 73.

[237] Ibid., p. 70.

However, a recently released GAO report, noted that:

> while peer reviewed NIH and NSF research funds appear to be concentrated in a few institutions and States, peer reviewers are more widely disbursed and therefore are not necessarily where the funds are.

Further, GAO reported that NIH and NSF R&D funding is less concentrated in the top ten schools than DOD research funds which are not generally subjected to external peer review as NIH and NSF projects.[239]

## CONGRESSIONAL RESPONSE

Members of Congress have also debated the issue of direct appropriations for university research facilities. Members who oppose direct appropriations contend the issue is whether research dollars are going to be spent on the basis of merit and competition instead of political criteria. Congressional supporters of direct appropriations argue on the basis of two beliefs. First, that the Congress has the right to ensure that Federal research dollars are allocated fairly in all regions of the country; and second, that earmarking research dollars for specific institutions is a long-standing congressional tradition.

One of the most recent congressional debates on bypassing peer review occurred in the Senate on June 5, 1986. The debate began when

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[238] Working On Capital Hill for Science and Profit. Science and Government Report, Dec. 1, 1985. p. 3.

[239] GAO, University Funding. Patterns of Distribution of Federal Research Funds to Universities. Briefing Report to the Ranking Minority Member, Committee on Appropriations. Feb. 1987. p. 53.

Senator John Danforth introduced an amendment to eliminate $80.6 million of earmarked funds that DOD was to spend at ten universities. (See appendix E for the list of universities.) Senator Danforth stated, "the issue before the Senate right now is whether research money to be spent for university research should be earmarked by the Appropriations Committee or, rather whether that money should be spent according to a competitive process . . ."[240] The Senator pointed out that in FY 1982 Congress earmarked $3 million for specific university projects, by FY 1986 that sum had increased to $137.6 million.

Senator Ted Stevens, Chairman of the Appropriations Subcommittee that approved the funds, noted that earmarking research dollars for specific institutions was an old practice that had benefited a number of institutions in the past. Therefore the Senator stated "those of you have already gotten money on a non-peer review basis, I ask you in fairness, why should we not use a non-peer review basis for defense research money?"[241]

Joining Senator John Danforth, Senator Jeff Bingamann argued a number of negative consequences resulting from the congressional designation process for awarding Federal funds to universities. The first, he said, is that "scarce resources are diverted from higher-priority research projects. Second, colleges are encouraged to become more involved in political strategies for obtaining funds than in developing the most competitive new scientific proposals."[242]

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[240] The Congressional Record, June 5, 1986. p. S 6890.

[241] Ibid., p. S 6893.

[242] Ibid., p. S 6894.

Senator Dennis DeConcini, defending a $25 million grant for Arizona State raised the issue of fairness. He said:

> over 50 percent of the Federal research money goes to 16 States every year . . . We have a right to compete, he said, We cannot compete. I am proud of my Arizona State University and the science and engineering technology center they have proposed, but they have done it without any Federal help so far because it all goes to the elite eastern or California high-tech schools. It is time we called a stop to that. We are talking about peer-review. Well, let us make peer review equitable, not just of the elite.[243]

Senator Long followed by indicating "I am sort of in the dark in this matter. When did we agree that the peers would cut the melon or decide who would get the money?"[244]

Senator Danforth reminded Senator Russell Long that included in the 1984 Deficit Reduction Act was congressional language to the effect that Government grants should be awarded competitively and that the peer review system was an appropriate process to use. To which Senator Long replied,

> Am I to understand that . . . Congress says we are not going to have any say about who gets this money: are we going to have some peers decide who gets this money? Now I understand why Louisiana has been getting so little. I did not know about it.[245]

Finally, Senator Thomas Eagleton argued that the Congress has no business determining what scientific projects the Department of Defense, the National Science Foundation, or the National Institutes of Health should be funding. He said, "Congress simply does not know enough to make those judgments."

> He continued by indicating that not one of the 11 projects had been requested by the Defense Department. Not one had been

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[243] Ibid., p. S 6897.

[244] Ibid.

[245] Ibid.

> authorized by Congress and not one would be subject to the established procedures for scientific competition.[246]

With the conclusion of the debate, the Senate voted in favor of the Danforth amendment, eliminating the earmarked funding for the universities. However, three weeks later, a House and Senate conference committee adopted an amendment providing funding for nine of the universities. (Funding for the Arizona State was not included.) On June 24 and June 26 the House and then the Senate approved funding the $55.6 million for the nine universities contained within the conference report.

In July the House took up the issue of bypassing peer review. The House debate focused on eight projects that the Appropriations Committee bill directed the DOE to fund in FY 1987. Three projects involved continued congressional support of research facilities that have been funded in the past, while the remaining five represented new starts. (See appendix F for the list of university projects.)

When the DOE bill reached the floor, Representative Robert Walker introduced and amendment to block funding for the projects. The Congressmen indicated that "the projects had not been peer reviewed for scientific merit and that the expenditure had not been approved by the House Committee on Science and Technology, which is supposed to authorize DOE programs."[247]

However Representative Tom Bevill argued that Congress should have some authority to determine where some of the Nation's Federal research dollars are spent. "We are being asked for Congress to delegate its responsibility to these peers to handle most of the research money in this country," he stated. "Let us let the Congress handle a little of the money."[248]

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[246] Ibid., p. S 6900.

[247] The Congressional Record, July 23, 1986. p. H 4766.

Representative Manuel Lujan, the ranking minority member of the Science and Technology Committee, opposed the Walker amendment on the basis of geographical distribution of Federal R&D money. He said that 51 percent of Federal R&D funds goes to only 31 universities, while 41 percent went to 20 universities and 26 percent went to only 10 universities. Further, no Southeast or Southwest universities are in the top 20. "Clearly, Congress has a role to play in redressing this imbalance," he argued."[249] Representative Walker's amendment was defeated 315 to 106.

## STATUTORY REQUIREMENT FOR PEER REVIEW

Despite the contention of some academic officials, requirements currently exist requiring peer review of certain research facilities. For example, as indicated in chapter four, the National Cancer Institute's, National Cancer Advisory Board (NCAB) is required by law (42 USC 286) to review all funds, public and private, for the construction of cancer research centers. The NIH has developed an agency-wide policy requiring peer review of proposed research facilities for all their research institutes based on this statutory requirement. Nevertheless, Congress can still become involved in facilities funding decisions after completion of NIH's peer review process.

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[248] Ibid., p. H 4768.

[249] Ibid., p. H 4770.

For example, the Senate FY 1986 appropriations bill for the Department of Health and Human Services (HHS), specified that $4.5 million should be transferred to HHS's General Department Management Fund and awarded to the University of West Virginia to help build the Mary Babb Randolph Cancer center. The original proposal to build the Center was reviewed twice by the NCAB and turned down both times. In qualified support for the peer review process, the final report of the Senate Appropriations Committee recognized "all Federal research money that this Center may obtain will be received through the peer review process as directed by the National Cancer Act."[250]

During the 1960s when the Federal Government had an active facilities program, Federal R&D agencies implemented a number of procedures for merit peer review of facilities. The National Science Foundation established peer review requirements for its "New Centers of Excellence" program. As an earlier chapter indicated, the major goals of the program were to develop new university research centers as well as improve the quality of science and engineering education. Some of the major considerations NSF developed for the peer review process were: the likely gain in scientific productivity per million dollars invested, commitment of State governments to provide matching grants, and the ability of proposing universities to recruit and retain faculty competent to conduct the new programs.[251]

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[250] R&D Pork Barrel: It's an Old Habit in Congress. Science & Government Report, Jan. 15, 1986. p. 7.

[251] Academic Research Facilities: Financing Strategies. National Science Board, Working Group Six. Federal Funding of Academic Research Facilities, 1986. p. 56. (Hereafter referred to as the Financing Strategies Conference.)

In the case of NASA's "Sustaining University Program," the agency relied on its own internal technical expertise to review university research facilities proposals. Different proposals were reviewed internally and decisions were made by the NASA administrator based on anticipated return on investment. Another major criteria was the institution's involvement in NASA's research programs.[252]

More recently, DOD utilized what might be called a procurement model to establish the Software Engineering Institute (SEI) at Carnegie Mellon University. After DOD had received congressional funding to establish the Institute, the Pentagon placed a request for proposals in the Commerce Business Daily and the Federal Register. The final seven proposals that were received were first reviewed by an evaluation board of civilian and military representatives including NASA and National Security Agency representatives. The Board conducted proposed site visits as well as evaluating the proposals technical merits. The next level of review involved civilian and military senior research executives, with the final decisions made by the Undersecretary for Research and Engineering. DOD acknowledged substantial lobbying, nevertheless, the Pentagon contends the final decision was made on the technical merits of the winning proposal.[253]

## COMPREHENSIVE MERIT REVIEW

In recognition of the controversy that has surrounded peer review of university research facilities, the Financing Strategies Conference introduced the concept of comprehensive merit review.[254] The report argues that proposals to fund the construction of academic teaching and research facilities require a broader review procedure than individual research grants. This was found especially true since many of these research facilities are perceived as important components of regional economic development.

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[252] Ibid., p. 57.

[253] Ibid.

The NSB report recommends that when developing a procedure for reviewing academic research facilities, funding agencies should seek a procedure for evaluating the technical merits of the proposal that ensures:

1. The existing or proposed programs of the institution in question are adequate to achieve the stated goals;
2. The people in place or proposed for conducting the programs proposed for the facility in question are capable of competent execution of the programs;
3. The proposed institution is able to achieve the goals intended by Congress and the agency involved;
4. The capacity of the area, or of the institution, is adequate to provide the transportation, communication, supplies, water, and other similar resources, and other necessary services; and
5. The cost of the facility will be reasonable.[255]

Finally the Financing Facilities Conference report acknowledges that the

> "allocation process for research facilities is not exclusively the result of a competition among proposals for identical facilities . . . the process is the result of an evaluation on a case-by-case basis of technical merit, local capabilities and aspirations, and other factors . . . social, economic, and political considerations."

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[254] Ibid., p. 53.

[255] Ibid., p. 55.

For these reasons, the phrase "comprehensive merit evaluation" best describes the process for review of research facility proposals.[256]

Essentially, some of the academic officials attending the financing conference were trying to restate their support of scientific peer review for facility funding, while recognizing other factors, including politics, would ultimately play a role in the final selection. Those at the meeting who opposed the idea of "comprehensive merit review" did so on the basis that it establishes no boundary conditions. They contended that a decision to fund a facility "could respond to any number of considerations that conceivably fall under its rubric." Further, the introduction of a new term will only confuse the current situation, "muddying the waters with imprecise guidelines, with decision factors that are not weighted and that are open ended."[257]

In spite of continuous outcries, led by AAU and other educational organizations, the practice of universities going directly to the Congress and bypassing peer review continues to grow. Consequently, AAU has declared for the time being, a "cease fire" and organized the "Working Committee on Principles, Policies, and Procedures in the Award of Federal Funds for University Research Facilities and Research Projects," to reevaluate the peer review issue. AAU's announcement indicated that "pressures on university leaders and Members of Congress that lead to earmarking show no signs of abating. The present circumstances is one in which all major organized voices of higher education and research oppose the practice, yet it continues and even appears to be growing." The announcement continues by indicating,

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[256] Ibid., p. 58.

[257] Ibid., p. 80.

> There is increasing concern in both government and the universities that we may face a future in which informed judgments about intellectual and scientific quality are no longer central to Federal decision making about funding for science and engineering.[258]

One of the unusual aspects of the announcement is the actual make-up of the committee. As expected the working committee will consist of university representatives, including Washington lobbyists that have lobbied Congress for facilities funding. Surprisingly, congressional representatives from both the House and Senate Appropriations Subcommittees on Labor, Health and Human Services, and Education, and the Legislative Assistant to John Danforth, will also serve on the committee.

The purpose of the committee's report, is to,

> review the present dilemma and to suggest ways in which university and government leaders might be brought into agreement on how funding decisions on university science and engineering research facilities and projects can be based on informed judgments of intellectual quality while recognizing other legitimate interests.[259]

The key phrase in this statement is "other legitimate interests." Those within the academic community believe that this phrase may represent AAU's willingness to recognize that broader consideration, other than strictly scientific merit review, must be weighed when decisions about university research facilities are made. This is what the participants of the Facilities Financing Conference had in mind when they introduced the idea of comprehensive merit review. One AAU official noted that after some of AAU's own members became recipients of direct appropriations, AAU President Robert M. Rosenzweig decided that his organization should reevaluate its position on peer review of research facilities.[260]

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[258] AAU Announcement on The Working Committee On Principles, Policies and Procedures. In The Award Of Federal Funds for University Research Facilities and Research Projects, Sept. 29, 1986.

[259] AAU Announcement, Sept. 29, 1986.

Although the final version of the report has not been released, the report now appears likely to urge higher-education associations to oppose congressional earmarking for facilities projects when the money is diverted from Federal R&D funds. The AAU committee is also expected to recommend that Congress establish a new Federal program to support academic facilities construction.[261]

## CONCLUSION

Many in Congress and academia believe the growing trend toward direct Congressional appropriations for facilities is a barometer of the need to modernize university research facilities. However, congressional earmarking of research and development funds may also be a perception of something much larger; the overall importance of American science and technological development as an engine for local, regional and national economic development. The development may also signify the evolution of direct political participation by universities at the congressional level.

Numerous reports, such as the President's Commission on Industrial Competitiveness and the White House Science Council: Panel On the Health of U.S. Colleges and Universities, have concluded that the overall health of the American scientific enterprise is vital to future U.S. international competitiveness. This was stressed by Representative Buddy MacKay when he stated:

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[260] Statement of an AAU official, Oct. 31, 1986.

[261] Personal communication with AAU committee member, Mar. 18, 1987.

> You can't sell peer review per se. I have sat on committees where you have tried. Let me tell you something: "peer review" is not a self-defining term, and when you finish trying to sell that concept to a group of people who have all kinds of other priorities on their minds, it is not coming across. You've got to sell peer review for some other reason, and that other reason has to be something that they and their constituents can get excited about, and I think the answer is competitiveness.[262]

Further, Members of Congress, and various State and academic representatives perceive university research and technology centers as a critical base for state and regional economic development. Therefore, Members of Congress and university officials are willing to bypass a peer review system they believe is not fair. Consequently, elected representatives will continue to receive pressure from various academic interests groups to make sure their universities possess the necessary infrastructure to become part of the scientific enterprise. As a result, it seems likely that direct congressional funding for scientific facilities will continue in the near future.

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[262] Financing Strategies Conference, p. 70.

# CHAPTER IX. IMPACT ON EDUCATION AND RESEARCH

## INTRODUCTION

A number of university research administrators have stated that outdated university research facilities have forced many universities to alter their science education programs, change laboratory exercises for some courses, or even cancel some classroom laboratory activities all together. According to the AAU study,

> researchers in all fields surveyed report a growing concern that the research and advanced education programs with which they are familiar are falling behind the leading edge in both quality and productivity . . . As a result, many departments in highly regarded universities are experiencing a growing difficulty in attracting and holding quality researchers and graduate students.[263]

The quality decline of research facilities, therefore, has been a major contributor to the loss of top researchers and graduate students, experienced by many universities, to the private sector where facilities are considered better. This shift may not result in a decline of the Nation's total research talent and effort, but it does mean a lessening of the kinds of basic, free inquiry research usually practiced in universities.

This chapter will examine the implications of potentially inadequate research facilities for graduate and undergraduate education and research at the Nation's universities. However, before examining this issue it is necessary to review some of the important benefits of conducting basic science research at the Nations' universities.

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[263] AAU Study, p. 11.

Linda S. Wilson, Vice President for Research, at the University of Michigan, in her paper, "The Capital Facilities Dilemma: Implications for Graduate Education and Research," noted that the three principal features of the U.S. science support system are concentration of basic research in the universities, integration of advanced research with graduate instruction, and emphasis on support of research projects rather than support of individual universities.[264] She pointed out that the integration of advanced research and graduate study is a primary characteristic of the U.S. system of higher education. It allows students to participate in original research in which they learn the latest techniques in various research fields and is primarily responsible for educating and training the Nation's future scientists and engineers.

The Wilson paper identifies a number of ways in which the current conditions of university research facilities affect the education and research capabilities at different colleges and universities. Further, other facility studies reviewed in this report, including AAU's, NSF's PI survey, and NSF's recent doctoral granting survey coincide with many of Wilson's findings.

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[264] Wilson, Linda S. The Capital Facilities Dilemma. In The State of Graduate Education. Ed. Bruce, L. R. Smith. Brookings Institution, Washington, D.C. 1985. p. 122.

## MAJOR AREAS OF IMPACT

### Quality and Productivity of Faculty

Wilson contended that perhaps the most serious impact of inadequate research facilities is the university's inability to recruit and retain the most productive faculty members and outstanding graduate students.[265] The AAU study reinforced this observation by indicating that their survey results showed,

> Some departments report almost insurmountable problems in their recruiting efforts, not only because of shortages of Ph.D.s in certain fields, but also because they are unable to offer candidates the modern research environments necessary to conduct competitive research.[266]

As an example, Dr. Kenneth Miller, a biologist at Brown University, predicted that because his university and others cannot purchase modern electron microscopes, American leadership in cell biology and ultra structural studies may well be surrendered to well-equipped laboratories in Europe and Japan. Miller believes that in the future America's best students may choose to study overseas, rather in American universities that have inferior research facilities.[267] Others in the academic community see this happening in the near future. Still others see an inevitable evolution toward a world scientific community with centers of excellence in various fields in several advanced nations competing and cooperating.

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[265] Ibid., p. 126.

[266] AAU Study, p. 11.

[267] Ibid., p. 12.

## Nature and Extent of Science Interaction

According to Wilson the current conditions of university research facilities affects the degree of collaboration and interaction among scientists and students in the same and different fields; consequently affecting the quality of education and impeding scientific progress. Further, Dr. Wilson argued that the dispersal of individual research groups because of unavailability of contiguous research space undermines the quality of graduate research training.[268] PIs in NSF's survey mentioned the problem of space more frequently than any other problem. In fact, 38 percent of the PIs said their research facilities were "crowded".[269]

Thirty eight percent of the research administrators in NSF's doctoral granting survey reported that a lack of campus space was a problem in addressing new facility construction. Essentially the research administrators said that the lack of available contiguous space prevented them from locating groups of scientific teams that must work together in additional new space.[270] Further, 95 percent of the research administrators said they had less space than they needed,[271] while 38 percent of the grantees in NSF's PI survey considered their research space crowded.[272]

Responding to the AAU survey, Dr. Ralph Angle of the Cornell University Medical School, stated,

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[268] Wilson, p. 125.

[269] NSF PI Survey, p. 11.

[270] NSF, Doctoral Granting Survey, p. 27.

[271] Ibid., p. A-9.

[272] NSF, PI Survey, p. 11.

> under present circumstances there is virtually no room for the development of new programs in biomedical research. We have no facilities adequate for recombinant DNA research. We have no storage facility for many hazardous chemicals. About 35 percent of our research laboratories have not been fully modernized since the buildings were built in 1932 . . .[273]

## Choice of Research Problem

According to Wilson the condition of research facilities also affects the type of research a university will select to pursue. She stated that "overcrowding, inflexibility of space, and inadequacy of environmental controls can surely stifle the imagination of students and teachers, especially if they perceive little or no opportunity for improvements."[274] The NSF doctoral granting survey,the AAU report, and GAO's University Finances study had similar findings. The NSF doctoral granting survey found that 92 percent of the research administrators said that the current condition of research facilities limits the types of research projects carried out on their campus.[275]

For instance, according to Michael Meshii, Chairman of the Material Science and Engineering Department of Northwestern University, indicated the Nation lacks the research facilities for producing ultra-high purity metallic specimens such as iron, the basic element of our modern technology. Other nations such as Japan and France are ahead of the United States. Dr. Meshii went on to state, "because of this American universities will likely miss out on the opportunity to discover and understand the intrinsic properties of

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[273] AAU Study, p. 12.

[274] Wilson, p. 124.

[275] NSF Doctoral Granting Survey, p. 26.

[ultra-high purity metallic specimens] iron and steel."[276] Twenty of the 23 universities that participated in the GAO study reported that the inadequacy of present research facilities was a "leading constraint" to the type of research they were currently conducting.[277]

Finally, limitations on research facilities may lead to conservative science. Wilson noted that those who decide what researchers have access to shared laboratory facilities may discriminate against research that has the potential for high payoff but is highly speculative. For example, Wilson speculated that with research space at such a premium, some universities officials may be reluctant to encourage their less established researchers to engage in what might be considered more theoretical research.[278]

## Validity of Research Results

Inadequate research facilities may also compromise the validity of research results. For example, Wilson pointed out that crowding can limit access to research facilities and reduce the experimentation and replication needed to ensure the generalizability of the original research work. Further, older research facilities usually experience more down-time, thus hurting research productivity. NSF' principal investigator survey found that 69 percent of those interviewed lost some research time, in some cases more than three weeks, due to facilities-related failure in the past year.[279] Inadequate air conditioning capabilities can lead to as much as 50 percent down-time in the summer months. Buildings with extensive deferred maintenance and just aging can experience leaks, which ruin instrumentation and experiments and interrupt current research.[280]

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[276] AAU Study, p. 18.

[277] GAO Study, p. 51.

[278] Wilson, p. 125.

[279] NSF, PI Survey, p. 13.

At UCLA, Dr. Tom Collins told AAU representatives that because of inadequate facilities, the engineering faculty is unable to undertake the kinds of research which are of most interest to them and which could greatly contribute to scientific advancement. Because UCLA does not have the most up to date equipment, researchers are often required to "jerry rig" equipment. This wastes valuable research time and often this "bailing wire and chewing gum" method runs the risk of generating unreliable or imprecise data."[281]

## Nature and Type of Instruction

The actual educational experience of college students appears to be very much affected by the current condition of research facilities says Wilson. The availability of research facilities for individual graduate students has a significant impact on how well that student is able to develop as an independent investigator. Wilson suggested that deteriorating physical plants and obsolete equipment have already placed many programs, especially engineering, far behind current professional practices. Wilson concludes that when universities lack in the state-of-the-art facilities they are unable to meet the needs of government and industry for highly trained science and engineering personnel.[282]

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[280] Wilson, p. 126.

[281] AAU Study, p. 13.

Dr. M.A. Eisenberg of the University of Florida School of Engineering echoed this observation in the AAU study when he said,

> perhaps the most insidious effect of our inadequate facilities is the impact on the education program. Future generations of engineers and scientists are being educated in an environment that does not reflect the current state of technology. To the extent we do not have modern facilities, we tend to perpetuate the teaching of outmoded methodologies.[283]

As mentioned earlier, this problem also transcends to undergraduate education as well. According to the Report of the White House Science Council, constraints within university research facilities also affect the extent to which undergraduates are able to participate in research. Laboratories which limit undergraduate participation in research will probably have a negative effect on the recruitment of undergraduates into graduate study as well as their preparation for graduate study.

## Responsiveness to Regional and National Research Needs

Research facilities also affect the transfer of technology to industry. The growing nature of university-industry cooperative ventures represents, in many cases, an expansion in the university's scope of interest. Many of these opportunities will require additional or updated university research facilities. This is especially true for cooperative efforts with high technology enterprises and other small business. Few of these organizations will have their own research facilities. Consequently, those universities that do not have adequate research facilities will not be able to take advantage of these cooperative venture opportunities.[284]

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[282] Wilson, p. 127.

[283] AAU Study, p. 13.

## Environment and Personal Safety

According to Dr. Wilson there is a concern that there are now a growing number of universities that are unable to take all the precautions to assure safety in the laboratory. As scientific research reaches into new areas, different and potential new hazards emerge and must be addressed. Universities that have limited resources to make major renovations in old buildings designed for an earlier era of research, often are forced to make difficult compromises. To some extent, safety education, efforts in laboratory "housekeeping", and extra attentiveness and careful segregation of risks can compensate for inadequacies in facilities. However, this usually results in some lost research and education productivity, not to mention compromising laboratory activities.[285] Over 30 percent of the administrators in NSF's PI survey indicated that safety concerns motivated past and current research facilities renovation activities.[286]

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[284] Wilson, p. 125.

[285] Ibid., p. 127.

[286] NSF, PI Survey, p. 5.

## CONCLUSION

A major consequence of a deficient research facility is its implications for the quality of future scientists and engineers produced at that facility. If U.S. colleges and universities as a whole, find it difficult to graduate top scientists and engineers, America's leading position in a number of scientific and technological fields could be challenged. Though this situation does not exist now, such a development might weaken U.S. scientific and technological leadership on which the Nation's economic health and national security depend. This potential threat and the need of many universities to upgrade their research facilities combined with interuniversity competition and reported limitations on sources of funds seems likely to keep the issue of how best to ensure and distribute quality research facilities before the Congress for some time.

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